PROPOSAL

THE MAIZETRAK ADVANTAGE

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MAIZETRAK

PROPOSAL

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Date November 20, 2000

Subject Proposal for Wireless Media Platform (The Maizetrak Advantage)

The members of Team Maizetrak have been asked to identify a need regarding the transmission of sound via the Internet and then research that need in order to design a viable product. In the rapidly expanding digital music industry, companies have been trying to market portable music players for the consumer. However, the current array of these digital players is inadequate as to what both the consumer and the industry need, not having features such as wireless transfer, a graphical, easy to use interface, or a large enough capacity. Therefore, a market need exists for a better Personal Audio Device. Research is needed in the area of Personal Audio Devices, audio encoding and compression, wireless data communication, a simpler interface, and a greater capacity. We at Team Maizetrak have taken up the task of developing a new Personal Audio Device, the Wireless Media Platform, which will include the features that are lacking in the devices on the market today, thus fulfilling the industry need. The purpose of this report is to present the details of the Wireless Media Platform for approval by our professors.

SUMMARY

Maizetrak will research and develop a platform for a Personal Audio Device that is suited to fill the needs of consumers and the industry. This product will contain the features such as wireless transfer, an easy to use interface, and a much larger capacity than the products on the market today. Today's market consists of three main types of

Personal Audio Devices, each of which has its clear disadvantages. The first type, the CD-based player, can store about ten hours of music, but it the owner must also purchase a CD-Recorder in order to make MP3 music CDs for it. The second product, the memory based player, connects to a computer so that the owner may store music, but tends to store no more than one hour of music. The third and newest product on the market, the hard drive based player, has an enormous storage capacity of about 100 hours and can connect to a computer or store directly to itself, but also costs arguably more than it is worth and is structured so that it is very difficult to search for songs.

Our product is built upon the features that the other Personal Audio Devices lack. When completed, the Maizetrak Advantage will be able to connect with a Handspring Visor to select songs, play lists, and control features. It will be hard drive based, with a capacity to store over 200 hours of music. The Advantage will be designed with the capacity to record directly and store files other than music for transfer between computers, and will possess wireless Internet connectivity so that the owner may be able to download music on the road. Lastly, this device will be upgradeable so that it may be expanded for future technologies.

The basis for the Wireless Media Platform (the Maizetrak Advantage) has been set by the members of Team Maizetrak, and the team has surveyed potential buyers in order to project the potential for this product to do well on the market once it is recognized. The remainder of this report is devoted to the specifics of our research thus far, so that this proposal may be reviewed in detail by the professors.

SOLUTION

Our team was very interested in the growing demand for Portable Audio Devices. Portable Audio Devices (PAD) allow the user to download music from their computer, off compact discs, or off the internet and store them into a portable device that will playback their music to them. Not only is it portable and easy to carry around like a compact disc player, but you can store a whole collection of compact discs. With our device we project to obtain 150 –200 hours of music playback. There are many devices on the market today, however, each of them lack a certain quality, or technology. Many devices on the market today are hard for the user to understand and too complicated to use. Other portable audio devices do not have the capabilities to sort or store a large capacity of music. In today's growing wireless community, we need a device that can provide to the user when he is at home or away from his computer.

In order to be recognized in today's market we must provide a device that currently is not available, and meets consumer demands and expectations. The gaps that are in the current market will be filled with a new type of portable audio device which is being researched by Maizetrak, called the Advantage, also know as the first wireless media platform. The Advantage will be easier to use because of the graphical interface other the Handspring Visor, the main control device. This will also provide the user with the ability to sort, re-title songs, and view their tracks more quickly and efficiently. They

will be able to enjoy over 150 - 200 hours of CD-quality music from the Maizetrak Advantage. The consumer will be able to merge his entire collection of MP3s and CDs in one compact device and never run out of tunes to listen to.

With its 10GB storage capacity, The Maizetrak Advantage will allow the user to store an amazingly large collection of digital music, all in a compact portable design. This device has no limits and is ideal for picking up tips from digital audio books, educational materials and for running through the minutes of that meeting you just had, learning the lyrics of your favorite MP3 song, or playing your favorite movie. That is where the word media comes in; It is not just for audio like most players on the market. Recording is also supported via the line-in jack. That gives you the capability to record from external devices, or between two Advantages.

Due to the modular interface the Maizetrak Advantage is upgradeable, and will allow the user to customize their Advantage. The Advantage will be able to support multiple compression formats, based on the users preferences, such as MP3, AAC, VQF, LPAC, and others witch are currently being researched. The Maizetrak Advantage will be able to be connected to a computer instantly with USB and wireless support. The Maizetrak Advantage is the response to a lack of options given to the consumer, while maximizing on quality, performance, size, and storage that is necessary in the market today.

BACKGROUND

There are currently three types of products on the Personal Audio Device, or PAD, market. These include the memory-based players, CD-based players, and hard drive-based players. All of these products have been successful on the market. They all have distinctive advantages, but more importantly, they all have several disadvantages.

The first type of PAD that is currently on the market is the memory-based player, such as Diamond's Rio 600. These devices can store approximately one hour of music. More music can be stored if the owner purchases additional memory cards. These cards, however, are extremely expensive and easy to lose because they are only the size of a postage stamp. This leads to a very high cost of ownership for these devices.

Another type of PAD that is on today's market is the CD-based player, such as the Philips eXpanium. These devices play up to ten hours of music off of data CDs. However, in order to store more music, the user must own a CD recorder in order to create more CDs to play. This adds a substantial amount to the cost of ownership of these devices. With CD-based players, it is very difficult to sort music because the LCD display only displays numbers.

The last type of PAD on the current market is the hard drive-based player, such as the Creative Nomad Jukebox. These devices can store substantially more music than the two former devices – between seventy-five and one hundred hours of music. As with

the CD-based players, however, these devices have a small display that makes it difficult to sort through the vast amount of music that they contain. For the single function of playing back audio files, these devices tout an extremely high cost.

All of the devices on the market share common failures. They are useful only for playback of audio. A user cannot record directly to any of these devices, nor can they store any non-audio files on them. None of the current PADs are wireless. In order to transfer music to or from the device, it must be directly connected to a computer. All of the current PADs are difficult to use and to customize. Even though a person may own a PAD, there is no substantial way for s/he to make it his or her own. [1]

DETAILS

Our proposed solution to these problems in the PAD market is a brand new type of audio device. It will be the first Wireless Media Platform (WMP), and we will call it the Maizetrak Advantage. The distinguishing feature of our product is that it will be designed to function with a Handspring Visor, a type of Personal Digital Assistant (PDA).

PLATFORM

The benefits of using a Handspring Visor to control the Maizetrak Advantage are myriad. Firstly, its graphical interface will allow for much simpler organizing of the vast amount of music stored on the Advantage. Imagine sorting through thousands of songs on a screen that only displays numbers – not an easy task. With the Visor's user-friendly graphical interface, a person can easily create, name, store, and edit playlists of his or her favorite songs.

Many PDAs, however, offer this graphical user interface. Why did we choose the Handspring Visor over others on the market, such as Palm's m100? The first and most important reason is that the Handspring Visor is a better value. Even though the Handspring Visor and the Palm m100 are based on the same software and cost the same amount, the Visor offers more features that useful for this project. For example, the Visor includes a USB connection, which is much faster than the m100's serial connection. [2] This will allow for faster data transfer between the Advantage and the Visor. The Visor also includes a Springport that allows the user to utilize different modules while using the Advantage. [3] For example, a person could insert a network module into the Visor and subsequently download music without plugging directly into a computer. This would allow maximum portability for the Advantage.

The Visor's open architecture, including the Springport and the easily upgraded software, guarantees that the Advantage will stay current for many years to come. [3] This makes it more attractive to consumers because they will not be wasting money on a product that will become obsolete.

The last feature that the Visor offers is an infrared port. [3] This feature would come in handy if a user had the Advantage connected to his or her home stereo. From across the room, s/he could use the Visor, without it being attached to the Advantage, to control the music playback. By beaming information with the infrared port, s/he could play or stop the music or even edit the playlist without being anywhere the Advantage. This also contributes to the overall flexibility and customizability of the Advantage. A summary of the Visor's advantages over Palm's m100 is shown in Table 1.

Features	Palm m100	Handspring Visor
USB?	No	Yes
Springport?	No	Yes
Infrared Port?	Yes	Yes
Price	$149	$149

Table 1

AUDIO

The main function of the Maizetrak Advantage is audio, which is a broad topic and can be broken down into a series of steps: Sampling, Compression, Storage, and Playback. As the Advantage is built on an open architecture platform for upgradability, each step must be as open as possible. At the core of the Maizetrak Advantage is a Digital Signal Processor (DSP), which controls the individual hardware components of the Advantage and also processes the audio in a highly efficient manner. The DSP is the power behind the Advantage that performs the difficult computing tasks of encoding and decoding audio, interface with the Handspring Visor, and transfer information between the parts of the Advantage.

SAMPLING

There are three sources for the music and sound files that will be stored on the Maizetrak Advantage. The first and easiest source will be to download files from a computer or network though either the wireless or cable connection. This requires only that the sound file be transferred and does not involve sampling directly by the Advantage, which is analogous to transferring any such file to the Advantage. A S/PDIF may be connected to the Advantage and a suitable digital audio source such as a compatible CD player or Minidisk player. S/PDIF is a digital audio protocol and transfer method created jointly by Sony and Phillips under the industry standard name IEC-958. It is the standard for consumer electronic equipment to transfer audio in a digitized manner between equipment but is also compatible with the professional audio standard AES/EBU with a simple converter. [4] By transferring the audio signal in a pre-digitized manner, the audio quality losses associated with analog transfer are nullified. From this point, the Advantage only has to compress the digital audio files by the appropriate method. A user may choose this method if using a S/PDIF com-

patible CD player without the intervention of a computer, or if they wished to incorporate the Advantage in a professional sound studio recording environment.

The third method of entering audio data is what makes the Maizetrak advantage the forerunner in portable audio technology. This method involves sampling audio via microphones or line level analogue inputs. Sampling involves the quantization of a continuous function into a discrete set of values in the time domain. Music is a very complex audio signal when looked at from the waveform perspective. Each instrument produces not only a fundamental tone at a frequency but also a series of harmonic frequencies above this note. Play multiple notes by multiple instruments at a time or add a voice and the signal becomes exponentially complex. The standard range of human perceivable audio is from 20 Hz to 20 kHz. Nyquist theorem (also Shannon Sampling Theorem) states that in order to reproduce all frequencies, the sampling rate must be twice as high as the maximum audio frequency to be sampled. [5] Any frequency over the Nyquist rate sampled will be *Aliased*, which will result in the digital data misrepresenting the original signal. Current microphone technology is able of picking up signals greater than 20 kHz, which can be produced by musical instruments as harmonics.

It is for this reason that we must take some measures to protect against this affecting our data. One method is to place a filter before the Analog to Digital Converter (ADC) that filters out signals above 20 kHz and make the sampling rate higher than 40 kHz. However, this leads to gross distortion of the signal as the filter must have very sharp characteristics. In response to this, digital methods are better used to filter the high frequencies. The signal to be sampled will be sampled at a rate of 64 times the Nyquist rate for audio, however at a lower resolution. This allows the initial filter to be very *soft* on the signal with a cutoff of approximately 300 kHz. The digitized signal is then put though a decimation filter, which uses digital techniques to filter out signals above the Nyquist rate for whatever resultant sampling frequency is desired, and by doing so increases the resolution. This technique is called oversampling, which is the basis for Delta-Sigma style Analog to Digital Converters. [6] This method is the used for almost all current consumer audio systems with a sampling rate of 44.1 kHz at 16 bits of resolution per channel. However, It can also be used for any sampling rate, such as 48 kHz, 96 kHz, and 196 kHz at resolutions up to 24 bits per channel such as used in professional and high-end audio equipment. [7]

The other important consideration in sampling sound is the resolution. When a sample is taken, amplitude quantization also occurs. At every specific time interval, a specific amplitude or value is measured. Because the value must be a digital number or *word* it is discrete, and no longer continuous. It is this discrete nature of digital audio that introduces distortion of the signal. The longer the *word*, the more numbers that can be represented, and therefore, the less distortion. A resolution (word length) of 8 bits yields 256 possible values. Current CDs use 16 bit word lengths per channel, where 16 bit are given to each the left and the right channels of the stereo signal. 16 bit words give a possible 65,536 different values. The reason why resolution is important is that it determines the dynamic range of the signal. Dynamic range is the difference between the loudest and softest sounds that are capable of being reproduced. The dy-

namic range of live symphony orchestra can surpass 120 dB, whereas 16 bit words have a maximum dynamic range of 96 dB. However, electronics inherently create some noise as a system. Related to the dynamic range is the Signal to Noise Ration (SNR) of a system, which is the difference between the largest possible sound produced and the inherent noise in a system. The SNR can never be higher than the maximum dynamic range. Because of this, the minimum resolution of the Maizetrak Advantage will be 16 bit words, stereo. However, to allow for higher fidelity recording and future audio specifications such as DVD-Audio, the Advantage will support up to 24 bit words, with a over 16 million possible values and a dynamic range of up to 144 dB. [8]

Therefore, the Maizetrak Advantage will use a Delta-Sigma ADC with oversampling capability to ensure the highest quality audio possible. For high quality studio settings, the output will be able to sample at up to 196 kHz at 24 bits per channel resolution. For more modest average recording by consumers, the same CD standard of 44.1 kHz/ 16 bit will be available. A benefit of the using this system in conjunction with a Digital Signal Processor is the ability to down convert a given sample to a lower quality and smaller sized sample. This is very desirable and would be used to record voice, such as in the case of recording a lecture. Only a 4 kHz sampling frequency with 8 bits of resolution is needed to adequately sample voice data, significantly decreasing the size of a given audio file before compression occurs. [14]

COMPRESSION AND DECOMPRESSION

Once a sample is captured, either by the ADC, or by direct transfer over an S/PDIF connector, it must be compressed so that it takes less space for storage and more efficient transfer though wireless or cable. Raw CD quality audio data takes 10.1MB for every minute of uncompressed audio. However, many methods exist for compressing audio into smaller files with compression ratios up to 10:1 and still maintain quality. Once compressed, the file must be decompressed to be played back.

The Digital Signal Processor (DSP) is the heart of this system. A DSP's main task is to handle the computationally intensive task of compressing and decompressing audio on the fly. It must be fast enough to do its task in real-time, which means that the compression and decompression take place immediately, transparent to the user. A DSP works at a specific word length, such as 16 bits, 24 bits, or 32 bits. The word length is the maximum number of bits that the DSP is able to process in one clock cycle. Because the Maizetrak advantage supports up to 24 bit resolution audio, a 16 bit DSP is unsuitable. In addition, when computing, a given algorithm may end up with a number greater than 24 bits, such as when multiplying two 24 bit numbers together. Therefore, to prevent the results from being truncated, and therefore distorted, a 32 bit DSP is needed.

A possible DSP that suits the needs of the Advantage is the Analog Devices ADSP-21065L. This DSP is capable of up to 198 million floating point operations per second (MFLOPS). This is important, because as the audio compression/decompression algorithm is able to compact music more, the computing need increases dramatically.

By having such a powerful and versatile processor as the core of the Advantage, it is ensured long life and the ability to upgrade to new and better codecs. This makes the compression ubiquitous to the user, who can now compress music and audio on the fly, away from his or her home computer freeing the user from needing access to a fast computer to compress music.

Lastly, the DSP has a number of general Input and Output connections that allow it to also function as an internal control for the Advantage. For example, if the user wished to connect the advantage to his computer and home stereo system and remove the Visor, the Advantage would still be able to function, even using the Visor as a comprehensive remote control.

If the DSP is the heart of the Maizetrak Advantage than the codec is its soul. Codec is an acronym for Coder/Decoder, and in this instance it is the software algorithm running on the DSP that does the actual compression or decompression. There are many codecs available to the audio industry, each with its own merits and drawbacks. However, the most widely known and used audio codec for music files is known as MP3. MP3 is actually ISO-MPEG-1 Audio layer 3, standardized by the Motion Picture Expert Group and created by IIS of Germany. IT was started in 1987 under the EUREKA project EU147 for Digital Audio Broadcasting. Because of the high industry focus on MP3, its popularity and widespread availability, we will focus on MP3s. However, for more information on different compression codecs. [9]

MP3 uses three tricks to shrink audio down to less than one tenth of its size and still maintain a reasonable quality. The first trick is a perceptual model based on the science of psychoacoustics. Psychoacoustics is the study of sound and music and its effects and relationships to human physiology and psychology. Humans don't hear all frequencies with equal sensitivity and are unable to hear soft sounds that are very near in frequency or time with louder sounds (masking). By using the perceptual model, portions of the original signal are thrown away, portions that most people would not hear anyway. This system leads MP3 to be "lossy" codec, which means that after decompression, the resulting signal is never the same as the original. This is different from a loss-less codec, which after decompression results in the exact same signal as the original. The second trick is to break up the signal into different *critical bands*, which are based on the psycho acoustic model. This uses a filter bank, and a Modified Discrete Cosine Transform (MDCT), which is similar to a Fourier Series Analysis of the signal. Each resulting critical band has less information than the signal as a whole and is compressed with less resolution. The last trick is to distribute the quantization error, that is the error introduced by using less bits, across the critical bands so that when decompressed the error is underneath the noise floor and inaudible. [10] The MP3 codec has a variable bit rate, which means that more compression is possible at the cost of audio quality. Bit rate is the speed of bits produced by a specific compression. Uncompressed CD audio (44.1 kHz/16 bit, stereo) has a bit rate of 1.34 Mb/s, where as a very high quality MP3 has a bit rate of only 160 kb/s (160 kbps MP3). This is profound, where the compression is almost a one tenth reduction of the original signal, therefore the same storage space is able to store 10 times the music. Other audio codecs such as AAC, VQF, QDMC, LPAC and MLP can be supported on the

same DSP at the same time, depending on the needs and wants of the customer.

STORAGE

There are two types of storage on the Advantage: permanent and temporary. These are also known as non-volatile and volatile. Non-volatile permanent memory stays on when the power is turned off. An every day example of permanent memory is a disk. Most Portable Audio Devices today use a form of non-volatile memory known as Flash RAM, which is a semiconductor-based memory. It can hold information without power like a disk can but it has no moving parts. However, it is very expensive, and from a manufactures perspective, very hard to acquire reliably. Disk based permanent memory such as a laptop hard drive has much more storage, almost one hundred times the space for half of the price. Because one goal of the Advantage is high capacity, a 10GB laptop hard drive will be used. The hard drive will also be able to store more than just music files. It will be able to store any other information or computer file that the user wishes, such as movies, books, pictures, and work.

The laptop hard drive does have moving parts though, and therefore takes more power than flash memory. In order to maintain the longest battery life, a second form of memory is used. Temporary memory is used to store a small portion of information from the hard drive as a buffer. The hard drive is only turned on for a very small amount of time when needed. This saves battery life and also eliminates skipping that would be found in CD based players. Because Flash memory is not needed, standard desktop computer memory known as SDRAM can be used. SDRAM prices have hit an all time low, and are easy to acquire. This arrangement of SDRAM used as a buffer for a hard drive leads to a very efficient and fast system, ubiquitous to the user.

PLAYBACK

When the user wishes to use the Advantage for playback, the decompression function of the DSP is used. Once the DSP decodes the compressed format into raw digital audio again, there are two outputs. The digital audio can be transmitted on an S/PDIF connector, to output to another compatible device, just like the S/PDIF was used as an input for input to the Advantage. The other output is analog, where a Digital to Analog Converter (DAC) is used. The analog output can be connected to a pair of headphones for personal listening, or connected to a home stereo or theater system for a more public and enveloping listening experience. It is this flexibility of the Maizetrak Advantage that gives it the real advantage.

Because the Digital audio is quantized, converting directly to analog results in a very stepped signal. Also, the output audio signal has the sampling frequency superimposed upon it as noise. Despite that this is inaudible and above the limits of human hearing, it can effect the audio signal in electronic circuits in the same way a carrier is modulated to produce unwanted results. Like in sampling, a sharp filter also can adversely affect audio. In sampling, the solution was to use an oversampling technique. The technique for a DAC is very similar. A circuit called an interpolation filter increases the sampling rate by a large factor and uses the sample information to fill in all

the holes between the known samples before converting the output to analog. This results in a much smoother output and eliminates the need for very sharp and poor filters at the output. Such DAC is called a multi-bit Sigma Delta modulating DAC. [6] This DAC must be matched to the ADC for sample rate and resolution to give the highest quality output. Therefore, a DAC supporting 196kHz sample rates and 24 bit resolution, such as the Analog Devices AD1852 is used. For simplicity an ADA (Analog to Digital to Analog Converter) can be used to replace the ADC and DAC chips with just one, saving board space and electrical power.

CONNECTIVITY

With any type of portable device you want to make sure that the user can plug it in quickly, download files, and go. The Advantage will use USB or Universal Serial Bus. USB is currently growing in the market today, and continues to be an effective way to connect a variety of external computer devices. With the Maizetrak Advantage we understand that you may not be in a place where you can get connected to a computer and download your new favorite song. So, to make it even easier the Advantage will be wireless. Wireless technology allows the users to network several devices, is very easy to expand, and cost effective. With wireless LANs users can access shared information without looking for a place to plug in. Wireless LANs offer real-time information and installation speed, reduce the cost of ownership, and can be configured for multiple devices, providing productivity, service, convenience, and cost advantages over traditional wired networks. One other way we will keep our customers connected is already a part of the Handspring Visor. You will be able to transfer data as well as control the Advantage even when the Handspring is not directly connected through the Infrared port.

The USB connection is one way in which the Advantage would allow users to transfer files to the device and their PC or Mac. The USB connection makes synchronizing with your desktop computer a whole lot faster and easier and is very easy for the user to install. The Handspring Visor also uses USB for a single wire connection to your computer . USB is currently a key feature on virtually every new notebook and desktop computer, which also makes it less expensive or difficult for the consumer to use. USB carries data at the rate of up to 12 megabits per second, which is 10 times the speed of uncompressed CD quality audio. [11] These devices include telephones, digital cameras, modems, keyboards, mice, digital joysticks, some CD-ROM drives, tape and floppy drives, digital scanners and specialty printers.

USB's data rate also provides for a new range of products such as MPEG-2 video-base products, personal organizers, and portable audio devices. By using USB we allow the users the ability to easily attach and detach several devices, which reduces the cost of ownership of these devices. USB is used everywhere. It is used in nine out of the top ten video conferencing cameras, nine out of the top ten scanners, eight of the top ten printers, the top three in flash memory card readers, and in three of the top four external CD-R drives, keyboards, and joysticks. In today’s growing market of computer production, sales of other market products continue to increase as these products con-

tinue to be developed with USB connectivity.

Bluetooth, Wireless Personal Area Networking (WPAN), is a new and advanced way to provide wireless connectivity. This will make it easier for the customer to use, while meeting and surpassing the current market with a product that has Bluetooth in it. It is projected by many sources that Bluetooth will revolutionize the wireless community. [12] The user will never have to loose time connecting wires, making every minute count. With the use of Bluetooth, consumers can download favorite music tracks in any setting, including while traveling, never having to worry about loose cables, a mess of wires, or even being away from home. With Bluetooth users can connect to a wide range of mobile devices quickly and easily, without cables. Bluetooth has quickly gained membership from companies such as 3COM/Palm, Axis Communication, Compaq, Dell, Lucent Technologies UK Limited, Motorola, Qualcomm, Xircom and is encouraging the involvement of all other companies interested in offering products taking advantage of a standardized, wireless means for connection.

This technology can be achieved by embedding tiny, low cost, short-range transceivers into the Advantage. This also can be accomplished through an adapter device such as a PC Card. The radio operates on the globally available unlicensed radio band, 2.45 GHz, and supports data speeds of up to 721 Kbps, as well as three voice channels. The 2.45 GHz band typically occupies 83 MHz of band width. The advantages of this band are that it provides a lot of spectrum space and doesn't require licensing of the radio devices. But the same advantages attract several other types of portable data devices that could interfere with each other. We should see Bluetooth devices and adapters coming into view by the late part of 2000. Initial cost will be around $20, however, it is eventually projected to fall in cost to around $5. The Bluetooth specification targets power consumption of the device from a "hold" mode consuming 30 micro amps to the active transmitting range of 8-30 milliamps, or less than 1/10th of a watt base on developers of Bluetooth. [13]

Bluetooth wireless technology is the next logical step. Bluetooth wireless technology will be built in to many mobile PCs, mobile telephones, and PDAs. And eventually, high performance Pentium III processor-based mobile PCs will be able to communicate wirelessly with other mobile PCs, connection points to voice or data networks such as LANs, cameras, headsets, and other devices such as the Advantage. The connectivity for Bluetooth will be achieved by a Springport module that will plug in to the back of the Handspring.

Another wireless network Maizetrak is evaluating is the wireless 802.11b, which is also available as a Springport module. This is another means of providing wireless technology to our customer. The 802.11b wireless local area network (WLAN) systems in today’s market also use radios in the 2.45-GHz frequency band. 802.11 is the first standard for WLAN products from an internationally recognized, independent organization. 802.11 compliant products expand the users' options. WLAN supports transfers speeds up to 11 Mbps. **See Appendix A**

The majority of the WLAN products available in the market today are spread spectrum, which target vertical applications operating in the 900MHz and 2.4GHz ISM frequency bands. Solutions for some applications are beneficial, especially for those requiring market differentiation or customization of a wireless LAN network. Solutions are typically customized and constrain the end users into purchasing products from a single equipment supplier. However, as products are introduced compliant to the standard, users can choose from a number of vendors that provide compatible products. This increases competition and provides the potential for lower cost products. Low costs and stimulation of market demand are some of the advantages that standards-based solutions offer. The client/server network uses an access point that controls the distribution of transmit time for all stations and allows mobile stations to roam from a given location. The access point is used to handle traffic from the mobile radio to the wired or wireless backbone of the client/server network. WLANs controlled by a central access point will provide better throughput performance.

The membership of the of the committee for the 802.11 WLAN working group is globally represented by companies from the United States, Canada, Europe, Israel and the Pacific Rim, consisting of individuals from a number of companies and universities, who research, manufacturer, install and use products in wireless LAN network applications.

Infrared (IR) systems [3] use very high frequencies, just below visible light in the electromagnetic spectrum, to carry data. Like light, IR cannot penetrate opaque objects; it is either directed (line-of-sight) or diffuse technology. Inexpensive directed systems provide very limited range of approximately 10-20 feet and typically are used for personal area networks but occasionally are used in specific WLAN applications. High performance directed IR is impractical for mobile users. With this already supported by the Handspring Visor you can use it to control the Advantage even when it is not connected directly through the infrared port. This will give the user more options without affecting the cost of the product. An example of the infrared port's operation would be to hook the advantage up to a stereo or even a television and use it to control which song you listen to, or pause the movie you are watching while you pause for a popcorn break. Maizetrak is currently on the right track in the research of the Advantage, and will continue to provide you with any upcoming information regarding the implementation of this product.

CURRENT MARKET

In order to fully understand the status and outlook for the market for personal audio devices and the potential for the Advantage, it is important to investigate how the general public rates the current market, and what it is or is not willing to purchase. Ultimately, we are interested in determining the potential market price of our product and what profits we project for the company. We begin by specifying the price ranges for the three types of audio devices currently on the market (i.e. the memory-based, CD-based, and hard drive-based). Currently, a memory-based player runs within the price range of $150-$200. A CD-based player has a larger price range of approximately $150-$250. The hard drive-based player currently is selling for $500-$600.

SURVEY METHODOLOGY AND RESULTS

After identifying the market prices of the three main types of audio devices, our objective was to evaluate consumer interest regarding each of these three types of devices. In order to do this, we distributed 200 surveys to likely candidates in the market for personal audio devices. The surveys described a typical version of each of the three main types of audio devices, then asked the potential buyer to specify what he felt was the fair market value of each of the audio devices described. The data compiled here served a twofold purpose. It allowed us to determine which product was preferred among consumers and indicated how much the consumers were under/overestimating the values on these products. The second part of the survey described, plainly and objectively, the features of our product, and then asked for an estimate on what the fair market value would be for it and asked whether or not the consumer would be interested in purchasing such a device. **See Appendix B**

Upon compiling the surveys, we computed the average fair market value for each product. These values were $146, $165, $342, and $532 for the memory-based, CD-based, hard drive based players, and our player, respectively. These values indicated that the consumers had underestimated the market values of each of the players currently on the market, especially in the case of the hard drive based player, for which the potential consumers underestimated the price by over 30%. The underestimates on the memory-based and CD-based players were both 18%, indicating that this was the area where most of the interest currently lies in the market for audio devices. (See Figure 1)

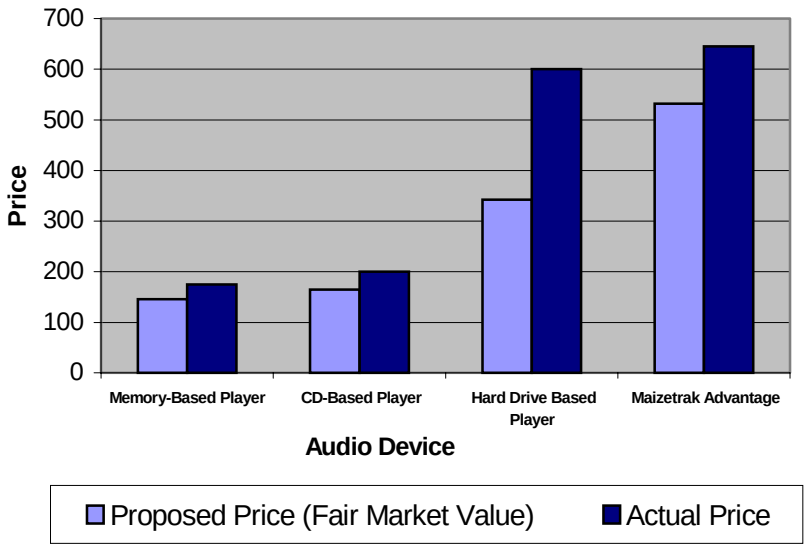

Figure 1

Our ultimate goal in the surveying process was to produce a price that would reflect the market price of our product , if it went onto the market today. In order to do this, we considered two factors, the fact that the potential buyers estimated our product at a cost of $532, and that the smallest difference between an estimated fair market value and the true market value was 18% (which occurred in two cases). In order to speculate the market price of our product, we added the 18% to the estimate of $532 to produce an estimate of $650, for which we should be able to sell our product once it has gained a reasonable amount of respect on the market. (See Figure 1)

SIGNIFICANCE

This price of $650 is significant to us because it indicates that we will profit from the sale of this product. The sum of the prices for all of the parts to the Maizetrak Advantage is less than $400, using the retail prices for all of the parts (the retail price is likely to be somewhat higher than what we actually pay for any part) yielding a minimum profit of $150 per product once the product gains a reasonable amount of respect on the market and the $650 market price can be achieved. These figures indicate that the Maizetrak Advantage is not only a reasonable product to place on the market but also a profitable one.

Obviously, in order to sell our products for the speculated price of $650, the product has to garner a level of respect commensurate with its features. This will prove to be a challenge to an emerging group such as Maizetrak, and this is exactly why Maizetrak will shift its marketing focus toward the goal of determining the best way to advertise our product and the best way to gain the respect that we need to sell our product at the $650 that has been speculated through the survey data.

CURRENT STATUS

Maizetrak has already done research to gather preliminary data on this project. For example, we have researched PDA platforms, wireless technologies, and marketing statistics. We do realize, however, that in order to successfully develop the Advantage, we have to delve into further research. Two especially important topics that we will look into will deal with the audio component of our product.

We have to research audio compression algorithms and techniques. These are important to our project because some techniques are inherently better than others. We need to discover which ones offer the best sound quality because we want the Advantage to stand out on the market due to its sound quality. On the other hand, we want to offer a maximum amount of flexibility with the Advantage; therefore, it will most likely support various compression techniques. This will lead to further research to determine which techniques will be the best to support.

Along with audio compression, we also need conduct further research on audio sampling rates. This will not impact the playback phase as much as the recording phase. By using a higher sampling rate while recording, the user will create a higher-quality

sound file. Consequently, the file would also be much larger than a lower-quality one. Only by doing further research can we decide on an appropriate sampling rate for recording.

While doing research, Maizetrak has encountered one major difficulty. We were unable to obtain data from some companies because they are unwilling to share anything with people other than corporate partners. It would be helpful to have this data so that we can get a better sense of what we can do with the Advantage. Therefore, we ask our instructors to help us in getting this data. If they can also assist us in distributing further surveys, it would greatly aid our project and we would be thankful.

In any project, it is essential to have a way of evaluating its progress. Without this, it is impossible to know whether or not the project is on track. By not knowing this, one cannot accurately determine whether anything has actually been accomplished by the project. Therefore, we have two ways of evaluating our progress with this project. We will create an evaluation survey to see if the general public thinks we have been successful. Toward the end of the semester, we will also ask ourselves if we have developed a product that meets the needs of the market and all of our stated goals. If we have, we will consider our project to be successful.

All of the data that we have collected points to one conclusion: the market for the Maizetrak Advantage is immediate. Once it is successfully designed, it can be built and sold to consumers immediately. The technology already exists, there is a definite gap in the market, and people are willing to buy it. Thus, we recommend the further development of the world's first Wireless Media Platform, the Maizetrak Advantage.

REFERENCE

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APPENDIX

THE MAIZETRAK ADVANTAGE

Advantage MAIZETRAK

APPENDIX A

THE MAIZETRAK ADVANTAGE

	IEEE 802.11b	Bluetooth
Speed	11 Mbps	30-400 Kbps
Use	Office or campus LAN	Personal area network
Types of terminals	desktop PC, palm device, Internet gateway	phone, palm device, pager, appliance, car
Typical configuration	Multiple clients per access point	Point-to-point or multiple devices per access point
Range	50 to 300 feet	30 feet
Frequency sharing	Direct sequence spread spectrum	Narrowband frequency hopping
Backers	Cisco, Lucent, 3Com, WECA consortium	Bluetooth Special Interest Group, Ericsson, Motorola, Nokia
Status	Shipping	In development
URL	www.wirelessethernet.com	www.bluetooth.com

This is a chart is a comparison between two wireless technologies; IEEE 802.11b features verse those of Bluetooth.

Personal Audio Device Survey
From Team Maizetrak

Please take a moment of your time to complete the following survey. This data will be used as research by Team Maizetrak to better focus our design process of a Personal Audio Device. This is for Engineering 100 Section 300.

Compare the features of these three portable audio devices currently on the market today and estimate the current retail value based on its merits.

Memory Based Player Fair Mkt. Value $_____

- 32-64MB of memory giving about 30 minutes to 1 hour of CD quality music
- Small, palm-sized, few controls or display functions
- Connects to computer to transfer music in MP3 format or similar
- Memory may be increased by adding memory cards, but max is 2 hours of music

CD Based Player Fair Mkt. Value $_____

- Like a normal CD player but also plays CD Recordable disks with MP3s on them
- Can store up to 10 hours of music
- Anti-skip memory built in, 50 seconds to 2 minutes
- Must own a CD-Recorder to make MP3 music CDs for it

Hard Drive Based Player Fair Mkt. Value $_____

- Large capacity, able to store over 100 hours of music
- Connects to computer to transfer music files
- Has a small screen that can tell song title, artist name, album (ID3 tag)
- Able to record directly to itself (such as live concerts, lectures)

The current retail price for a Memory Based Player is $150-250 depending on built in memory and options, with a 64MB flash card costing >$100. A CD Based Player costs $200-250 not counting the price of a CD-R, and a Hard Drive Based Player costs $500-700.
We at Maizetrak are engineering a new breed of Personal Audio Device. We would like you to estimate its fair market value. It has the following features:

- Connects with a Palm Pilot/Handspring Visor to select songs, play lists and control features
- Hard Drive Based for over 200 hours of music
- Able to record directly and store files other than music for transfer between computers
- Wireless Internet connectivity, download songs on the road directly to the device
- Upgradeable, and expandable for future technologies and trends

Fair Market Value $_____

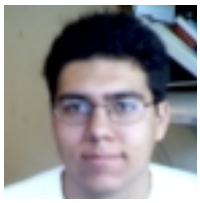
Would you be interested in owning this device? Yes_____ No_____

We at Team Maizetrak thank you for your time.

Advantage MAIZETRAK

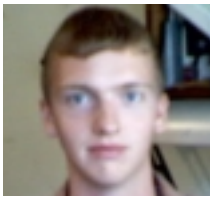
APPENDIX C
THE MAIZETRAK ADVANTAGE

TEAM MAIZETRAK



James Glettler
Electrical & Acoustic Engineering
Freshman Class of 2000
3209 Stanley House, Baits
jglettle@engin.umich.edu

I come from Ada, Michigan, which is right next to Grand Rapids. I chose the University of Michigan because it offered me the opportunity to hone my engineering skills while broadening my horizons. I love the challenges of electrical and acoustical engineering as much as I enjoy the product. Outside of high school, I focused my education mainly two ways. I started an audio engineering firm, Elysian Audio, starting relationships with companies such as DuPont, National Semi, and TI. I also was involved in Science Olympiad competition. At the 2000 national tournament, my "Mission Possible" device placed first. I hope to be a positive team member in Maizetrak.



Paul Johnson
Electrical Engineering
Freshman Class of 2000
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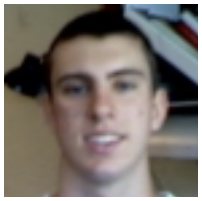
johnpaul@engin.umich.edu

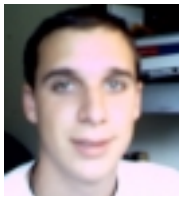
Originally from New Haven, Michigan, I came to the University of Michigan because of the strength of its Engineering Department and because it is a lot closer to home than Cornell is. In high school, I excelled in several subjects, winning departmental awards in math, science, and English. I also received a National Merit Scholarship, the Bausch & Lomb Science Award, and the Engineering Scholarship of Honor. I believe that my leadership experience as the president of my school's National Honor Society and captain of our Quiz Bowl team will help our team to work more effectively. After graduating, I intend to specialize in telecommunications engineering so that I can impact the lives of many people.

Chris Vermillion
Aerospace Engineering
Freshman Class of 2000
5071 Stanford, Bursley
cvermill@engin.umich.edu



Being originally from Sagamore Hills, Ohio, I chose to attend the University of Michigan for it's excellent reputation in engineering. Throughout high school, I have excelled in mathematics and sciences, receiving awards and scholarships from organizations such as the Cleveland Technical Societies Council, American Mathematics Competitions, and the National Merit Scholarship Competition. I have maintained a versatile high school experience by participating in cross country, swimming, and track, and I continue to stay involved in college. I am certain that my analytical skills, coupled with clear and effective communication skills, will be an asset in this project.

Tony Vittorini
Mechanical Engineering
Freshman Class of 2000
3609 Lewis, Bursley
avittori@engin.umich.edu



I am originally from Macomb, Michigan. I chose the University of Michigan because I consider it to be a place where I can develop my education as an engineer, while growing in the culture of it location and diverse student population. This unique university will give me the opportunity to reach new heights an surpass previous goals. Throughout my high school career I took on many active leadership roles such as President of the National Honor Society and Student Council President. I feel with my leadership and team building skill I will be able to contribute to the growth and development of Maizetrak.

APPENDIX D

THE MAIZETRAK ADVANTAGE

GOALS

Maizetrak consists of a group of four engineers. These Engineers have been assigned to work together to complete and develop solutions to the projects that have been delegated. The members of this group have developed four main goals which they plan to use as their basis for all projects assigned to the group, and will strive to obtain the best possible product.

Together the group has a lot of outstanding abilities and expertise. The group consists of several varsity scholar athletes. All of the group members have taken on leadership responsibilities such as President of National Honor Society, and Student Council President. All of the members have taken part in community service projects and volunteer opportunities. The members of Maizetrak have all played musical instruments. Several members have obtained national awards which include the National Merit Award, and Nation Association of Secondary School Principal's Award.

They are ready as a team, ready to meet their future. Maizetrak is looking forward to the new challenges that await them, and is ready to uncover new territory. Ready to lead our future . . .

EFFECTIVE & CLEAR
COMMUNICATION

POSITIVE
TEAM BUILDING
& EQUAL WORK

COMBINE OUR
UNIQUE
ANALYTICAL & TECH-
SKILLS
TO SOLVE PROBLEMS

RECOGNIZE
ETHICAL SITUATIONS

www.maizetrak@hotmail.com

WHAT IS YOUR ADVANTAGE?

The Maizetrak Advantage

TEAM MAIZETRAK

Tony Vittorini
James Glettler
Chris Vermillion
Paul Johnson

Email: maizetrak@hotmail.com

ADVANTAGE
WIRELESS MEDIA PLATFORM

The Maizetrak Advantage. Willing to lead the world into a new era of wireless media platforms. It just doesn't get any better than the Advantage.

WHAT IS YOUR ADVANTAGE?

The Maizetrak Advantage

TEAM MAIZETRAK

Tony Vittorini
James Glettler
Chris Vermillion
Paul Johnson

Email: maizetrak@hotmail.com

If you would like to learn more about our company feel free to contact us at www.maizetrak@hotmail.com. We will be free to share with you current minutes and updates on our project, events, and discussions.