A User-Friendly MP3 Player for Music Therapy

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Team:
Joel Webb – *BSAC*
Jonathan Mantes – *BWIG*
Joey Labuz – *Team CoLeader*
Derek Klavas – *Communicator*
Michael Conrardy – *Team CoLeader*

Client:
Dr. Kristine Kwekkeboom, PhD, RN
School of Nursing, UW Hospital

Advisor:
Professor John Webster, Ph.D.
Dept. of Biomedical Engineering

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Abstract

The goal of this design project is to develop a user-friendly MP3 player for elderly cancer patients. Current designs of MP3 players are difficult to operate for elderly people with limited motor skills and minor disabilities. Research indicates that music is an effective way to induce relaxation and distraction for patients to help manage pain and fatigue [3]. In order for music therapy to be an effective tool in pain therapy, patients must be familiar with MP3 devices. By creating a MP3 player that is easy to use, patients will be able to take full advantage of music therapy.

Background

Music has been shown to improve mood, promote relaxation, and induce sleep in elderly cancer patients. Despite these findings, however, implementation remains low [5]. Soothing music and its subtle vibrations stimulate these responses [3], and for a patient experiencing chronic pain, it can be a welcomed distraction. When utilized as a treatment, nurses usually monitor this type of relaxation therapy. However, advancements in technology have allowed music therapy to be implemented almost anywhere.

Being able to control where and when this musical intervention takes place is very beneficial to the patient. In fact, research has shown that patient expectations play a significant role in the success rate of such pain therapies [4]. Portable devices such as mp3 and CD players have made it possible to make relaxation therapy feasible within, as well as away from, the clinical setting. When music therapy is coupled with a relaxing setting, the effects can be invaluable to the patient. This method of therapy is in no way a

cure for cancer, but it has been able to help patients fall asleep and relieve pain for short periods of time.

Problem Statement

Currently, our client's group is conducting a research study using recorded relaxation, distraction, and imagery exercises to help patients with cancer manage their symptoms – including pain, fatigue, and sleep disturbance. In today's busy cancer care settings, there is not sufficient staff or time to provide these symptom management strategies precisely when and where patients need them. Their team has developed an intervention using recorded strategies that are delivered on an mp3 player. However, because cancer is a disease associated with aging, many of those affected are unfamiliar with common mp3 devices. Moreover, the elderly may have difficulty seeing the small display screens and text, as well as have fine motor limitations that interfere with operating small controls.

In a recent feasibility study done by our client's group, older cancer patients said that they enjoyed learning to use the mp3 player and listening to the recordings, but struggled with managing controls (on / off / hold), and navigating between recordings and menus [4]. Our goal is to develop an mp3 player that will be easy to use for older patients: a device with an easily visible screen, large buttons, and simple navigation options. In addition, data gathering features might also be built into the system to make research easier for our client. For example, the device could have the ability to monitor treatment 'dose' by logging specific recordings played, length of time they were played, and frequency of plays. Finally, the device must remain portable, allowing the patient to apply the therapy in a variety of locations.

Motivation

The current mp3 players used by the school of nursing are second and third generation iPod Nanos (Figure 1). The iPod Nano has a very small click wheel (2.5-3.25 cm diameter) for navigating its menu, which is displayed on a small screen (5 cm for the 3rd generation or 3.75 cm for the 2nd generation). Dr. Kwekkeboom has found that some patients using these mp3 players have trouble seeing this small screen and navigating the menu using the click wheel.

Figure 1. Second generation Apple iPod nano. The white click wheel is sensitive to touch and is operated by moving finger around it. (www.letsgodigital.org)

Besides the physical difficulties with the device patients also reported that they had trouble navigating through the different settings, menus, and options of the interface. By fixing these problems and creating a user-friendly mp3 player for elderly patients, music therapy will be available to a larger percentage of the population. In addition, this will improve the treatment, allowing patients to listen to therapeutic exercises in relaxing locations and in times of greatest need. Most importantly, this device has the potential to improve the quality of life for suffering patients by easing pain and improving mood.

Client Requirements

After meeting with our client and performing a brief review of the literature, we have determined several criteria that the device must meet. While our client only requires one prototype, it is our goal to have a device that can be produced on a large scale – if our client so chooses – for under $250. It is important to our client that her patients be able to carry this device with them, so for the purposes of mobility, the device should have a mass no greater than one kilogram and have a base no larger than 150 cm^2. The weight of the device is of particular importance since many of the prospective users will be suffering from the debilitating effects of old age and disease.

The device must be able to play 12 different relaxation therapies. These 12 therapies will be organized in four different categories of three songs each. Since ease of use is a primary goal of this project, it is critical that the different therapies, categories, and navigation options are presented as clearly and intuitively as possible; especially because most of the patients will be unfamiliar with mp3 player technology.

The device must also focus on accessibility. The screen will be much larger than a normal iPod and the menus and buttons will be designed so that users unfamiliar with current technology will be able to navigate the device with ease. Furthermore, any buttons will have physical boundaries in order to provide the user with tactile feedback. Since the device may be used in hospital setting, the device should be nontoxic and should be able to withstand being disinfected. Finally any materials used in conjunction with the mp3 player should be non-magnetic, in order to avoid interference with the mp3 player or other hospital equipment.

If time permits, we also plan on designing a data-gathering program for this device. This program would survey patient pain levels before and after therapy and record this information. In addition, it would record which therapy was selected. Our client could then upload the data onto her computer and analyze any patterns that emerge. This could prove to be an extremely useful tool for quantifying the effects of this sort of pain management therapy. It would also be instrumental in determining which types of music therapy work best for certain types and levels of pain.

Existing Devices

There are currently no mp3 players on the market that have been specifically designed to accommodate the elderly and/or handicapped. However, there are several products that involve an external remote control that possess accessible button arrangements, and make it easier for the user to navigate through the audio files. For the purpose of this paper, we will focus on existing devices for Apple's iPod, as it is the mp3 player of choice for our client.

One such device is the Air Click made by Griffin technologies (Figure 2). The external remote control is able to communicate with the user's iPod through radio frequency signals received by a transmitter plugged into the bottom port of the iPod. The five-button layout on the control includes buttons for play/pause, next song/previous song, and volume controls. This simple five-button layout would be easier for an elderly user to understand than the iPod's touch wheel, but could still pose problems with regards to the size of its buttons.

Figure 2: Air Click by Griffin Technologies [1] with five button layout for navigation, play/pause, and volume control

Another device that is similar to the Air Click is the Monster iEZClick made by Monster Cable. The iEZClick also communicates with the iPod through radio frequency signals and contains a five-button arrangement that increases the ease of access for the user. One major benefit that can be seen below (Figure 3) is the oversized play/pause button in the middle of the controller. One downfall of the iEZClick is that in order to navigate to the next play list, which will be a frequently performed task, the user must simultaneously hold the play/pause button along with the next song button.

Figure 3: Monster iEZClick by Monster Cable [6] with similar functions as airclick, but bigger pause/play button

Both of these models are suitable options for increasing the user-friendliness of iPods and their general concept could be applied to any type of mp3 player. However, the

buttons sizes are not of desirable dimensions, as specified by our client, and forcing the user to monitor and iPod and external control at the same time could be overwhelming.

Design Proposal 1 - The iPod Exoskeleton

The mp3 exoskeleton was the first option we explored when brainstorming designs. The goal was to create a lightweight, non-bulky device that would contain the mp3 player. The purpose of the exoskeleton would be to increase the visibility of the mp3 player's display screen, and also to provide buttons that are larger and more user-friendly.

The design incorporates a box frame made out of a hard plastic material (possibly acrylic) and contains a hinged door for the top face of the box (Figure 4). With the top face opened, the iPod can be placed inside and secured into position. Built into the top face is a magnifying lens that sits directly over the iPod display screen when the door is closed. This will magnify the iPod screen during use, making it easier for users with impaired vision to see.

The most critical part of this design prototype is the interface between the iPod buttons and the buttons of the exoskeleton. As evident in Figure 4, the exoskeleton buttons are connected to the iPod buttons through internal wiring. Because the iPod buttons are part of a scroll wheel that is touch sensitive, creating this interface suddenly becomes very difficult, as the electric signal from the exterior would have to be converted to the application of pressure by a finger in some way. Our current research has yielded no possible way to achieve this. We have examined the possibility of disassembling the iPod in order to gain direct access to its internal circuit board, however once this occurs, the iPod cannot be reassembled and would only be able function when inside our

exoskeleton device. This is a limitation that could prove to be very expensive in the long run.

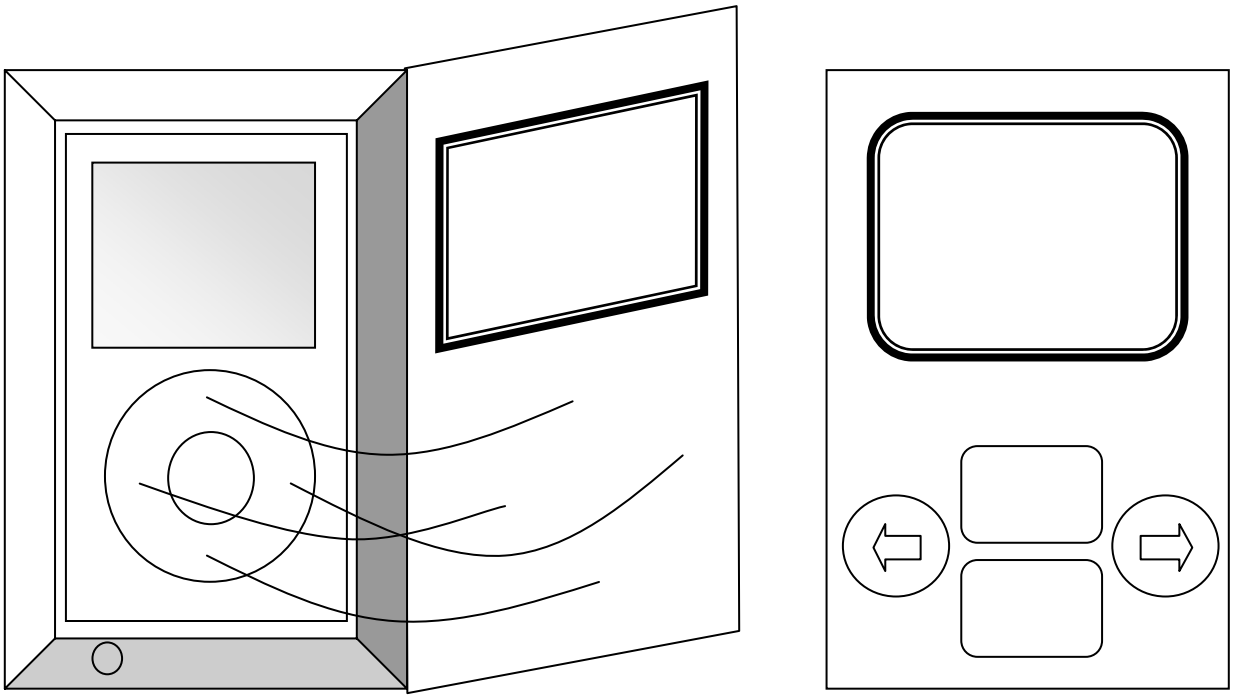

Figure 4: Sketch of the basic layout for the iPod exoskeleton. The user interface would have a similar five button scheme as current devices, but button features would be larger and more intuitive

While the exoskeleton device provides several advantages to the user and answers the challenge of creating a user-friendly mp3 player, it does have various drawbacks. In order to encompass the entire iPod and wiring required for the iPod-exoskeleton interface, the final product would be extremely bulky. The second drawback is the production of just a single exoskeleton would be time-consuming and require significant funding to obtain all the required materials. Since each exoskeleton will be intricately wired to its own iPod, the construction of every device would entail purchasing a whole new iPod as well.

Design Proposal 2 - An External Controller for the iPod Nano

The problem with the initial design of the iPod is that the controls are hard to manipulate for elderly and disabled people. An external controller may provide another way of making the mp3 player easier to use. There are many designs of external controllers on the market but they all include small button sizes not suitable for this design project. The "wheel" design used to control the iPod is very sensitive and hard to use for people with limited or impaired motor skills – such as those with arthritis. Since this project is intended for elderly patient use in pain therapy, large button size and a high degree of usability is critical for a successful design.

This design incorporates an external controller that is either wired to the iPod (Figure 5) or synced wirelessly. Current designs on the market have both options, but none of these products have large buttons. However, a simple, large button control could be created by taking a commercial product (such as the Air Click by Griffin) and modifying it.

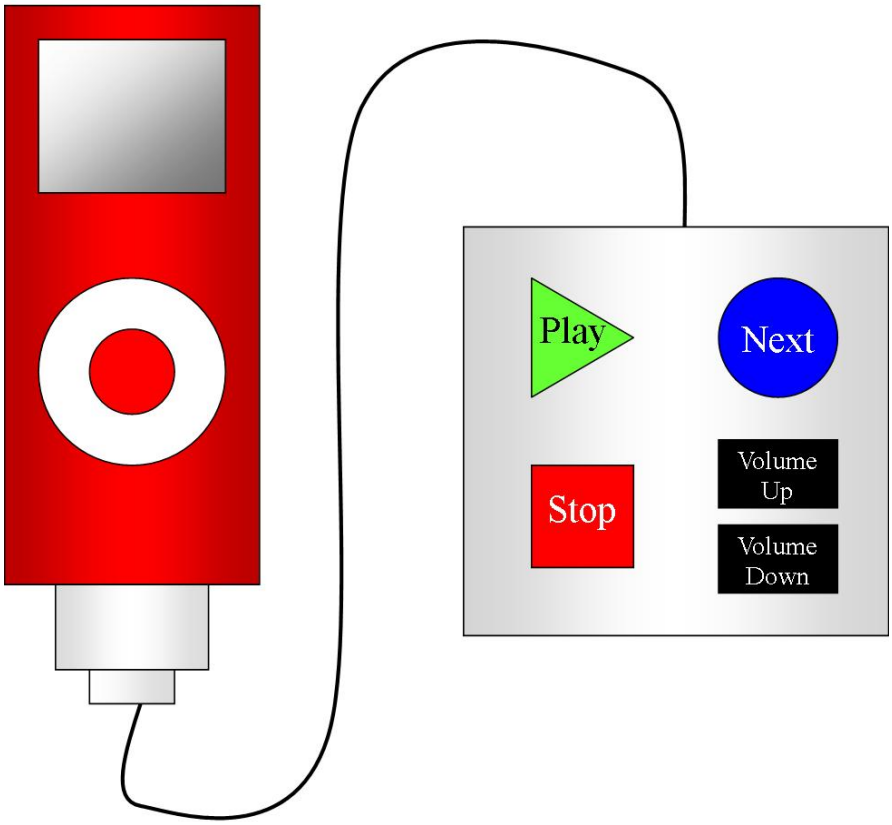

Figure 5: Sketch of a wired external controller for the iPod Nano. Again, a similar five button layout would be employed, however, this interface would be much easier to construct and more versatile than the exoskeleton design.

The new control would consist of a plastic case containing the circuitry of an existing control. The buttons on the modified controller will be about 6.25 cm^2 so that the user can easily find and push them. The buttons will be color and shape coordinated, making it easier for persons with impaired vision to use the controller. There will be five buttons including play, stop, next, volume up, and volume down. In addition, the iPod will be modified so that only the necessary menu options will appear. Only songs necessary for pain therapy will be loaded onto the iPod, ensuring that the user will not find files unassociated with their treatment. The controller will be approximately 7.5 cm wide by 7.5 cm tall by 2.5 cm thick, which will fit easily into the user's hand. The dorsal

side of the controller and the mp3 player will backed with a non-sliding material so the unit will not move when set on a hard surface.

Advantages of the external controller design include a large, easy to hold controller, easy to use buttons, and a non-slip backing. The controller is larger than the iPod which makes the device easier to hold and more comfortable to grip. The device also has color and shape coordinated buttons to make the layout more intuitive. The non-slip backing allows the iPod and controller to be placed on a hard surface without sliding.

Disadvantages to this design are the small screen size, the separation of the two components, and the ease of navigation. The screen size is the stock iPod size which was relatively small and hard to see. The device is now two pieces – the iPod and the controller – which make the unit less portable and harder to manage. The ease of navigation on the iPod is limited to only the options on the external controller. Choosing the correct song may be tiresome since there is only a next button on the controller to change from song to song. These advantages and disadvantages make the design a possibility but there are still some aspects of this design that could be improved.

Design Proposal 3 - A User-Friendly Interface for the iPod Touch

Our team's final design involves the development of an application for the iPod Touch or iPhone (Figure 6). Both the iPhone and iPod Touch use the iPhone Operating System and can run a variety of applications; anything from a simple four-button interface to a video game with real-time 3D

Figure 6: The iPod Touch [2]

graphics and 3D positional sound. These applications can be developed using the iPhone Software Development Kit (SDK) and potentially distributed through the Application Store [1].

The SDK consists of three primary components: Xcode, Interface Builder, and the iPhone Simulator. Xcode is the primary development tool, in which files are organized and code is written. The programming is done in a language called Objective C which is an object-oriented programming language derived from C. Along with this is a program called Interface Builder. Interface Builder makes it easy to set up the layout for the interface and design the look of the menu. It creates nib files that are imbedded and referenced within the code. Finally, the application can be tested and debugged using the iPhone simulator, an application that realistically simulates the behavior of the program when run on an iPhone or iPod Touch.

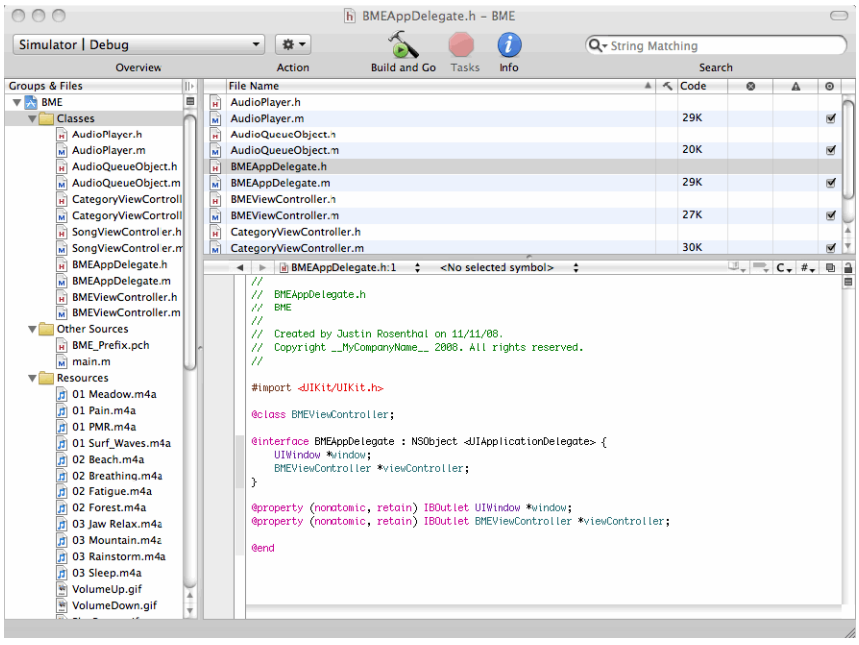

Figure 7 - Screenshot of our Xcode project showing the files, their organization, and a sample of code.

Our team will utilize the iPhone SDK to create an iPhone application for Dr. Kwekkeboom's research. This application will make it easy for patients to play any of 12

pain therapy tracks. These songs are organized into four categories of three songs per category. Within the application, there will be three different menus, each containing four buttons (1.68x3.21cm). The first menu will have one button designated for each of the four categories. When the user chooses a category by pressing one of these buttons, he or she will enter the next menu. This will have three buttons for each song, as well as a back button located in the upper-left hand corner, allowing the user to go back to the previous menu. If a song is selected, they will enter the third menu. This menu has a play/pause button at the bottom left, a back button at the top left, and two volume control buttons on the right-hand side of the display. These three menus are the major component of the application, and are the only components for patient use. Shown in Figure 8 is a flow chart of the menu progression.

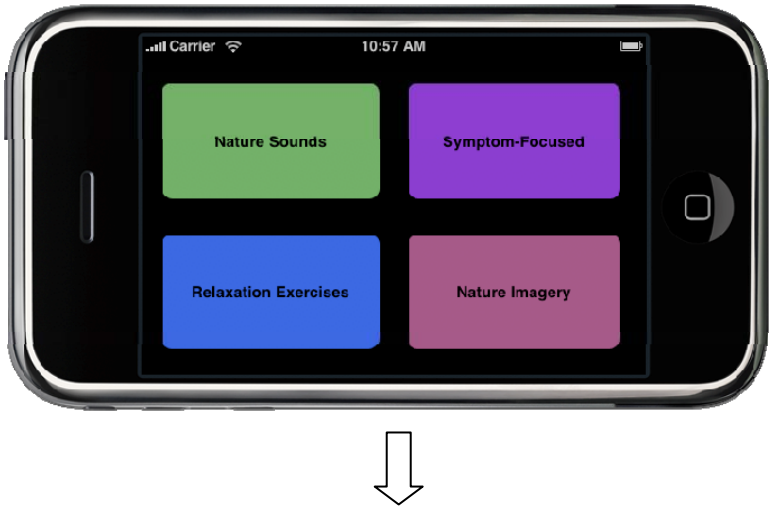

Figure 8 - Flow chart showing menu progression for the application

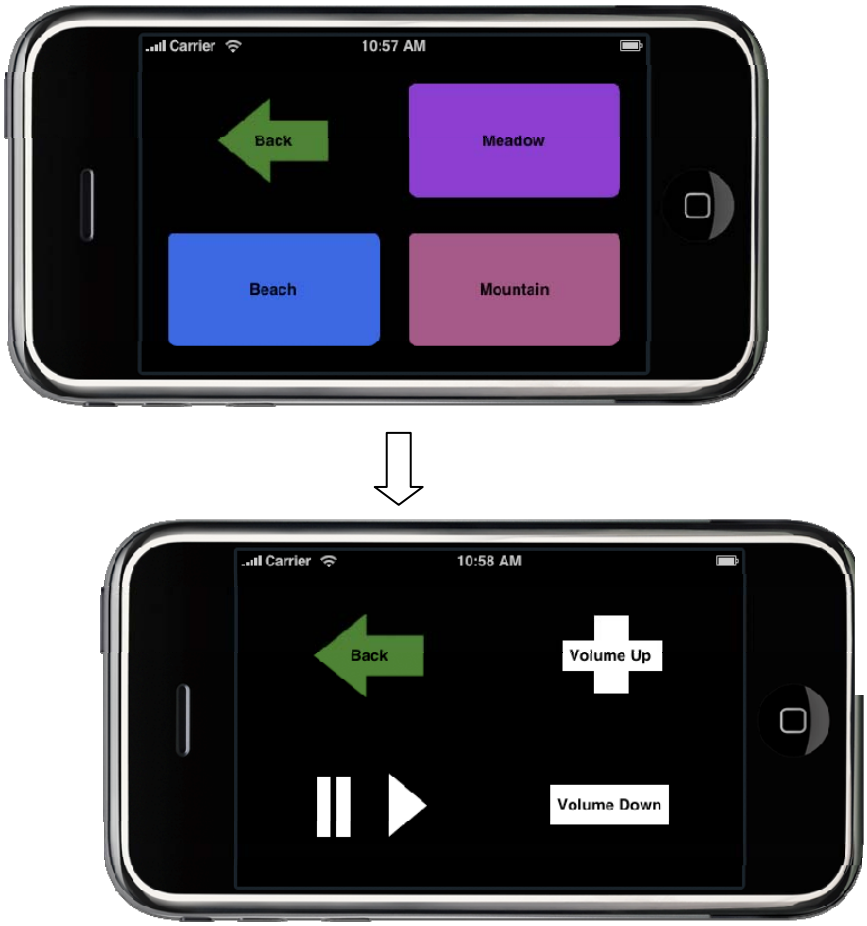

Figure 8 (cont) - Flow chart showing menu progression for the application

Along with the iPhone application, our team will construct an iPod Touch case specifically designed for use with the program. It will be constructed with a hard, durable plastic called Acrylic Butadiene Syrene (ABS) very similar to PVC. The interior cavity of the case will fit tightly around the iPod Touch (10.75 cm by 6 cm by .825 cm), and the plastic surrounding the iPod will be approximately 0.625 cm thick (Figure 9). The purpose of this case is not only to protect the iPod, but also to allow patients to feel the location of each button. For this, holes will be placed on the top of the case (the side over the screen) to allow the patient to use the program while receiving tactile feedback to provide the location of the buttons. Since not all users would have such requirements, the necessity of the case could be evaluated on a patient by patient basis.

The case will be made of ABS which was chosen for its high impact resistance and good machinability. The bottom, being a relatively simple design can be done by hand using the mill. The top however is a much more intricate design and as such, was fabricated with the aid of the Computer Numeric Control (CNC) mill and an accompanying program written to specify the layout of the holes. The dimensions are described below in Figure 9 and are designed to exactly match the positions of the buttons, slide bar, and menu button on the iPod touch.

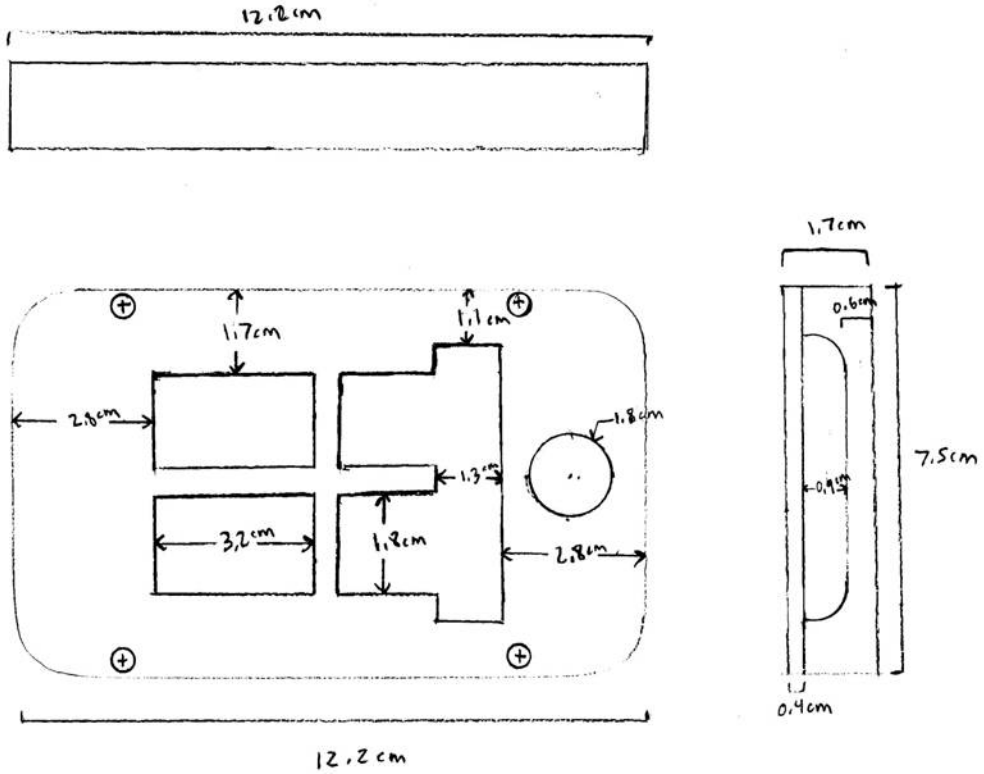

Figure 9 – technical sketches of the case [7]
Clockwise from the top: side view, bottom view, and plan view

The design of a program and complimentary case for the iPod touch offers numerous advantages. First of all, it is easy to duplicate and distribute. The user merely has to download the application from the application store (http://www.apple.com/ipodtouch/appstore). This would be an incredibly cost effective

design option. Once the program is created, the cost per device would be the price of an iPod touch (currently $229). For the patient, the device is easily portable with its small size and weight (0.18 kg), and the simplified interface we create will make the menus and controls much more intuitive. The only disadvantage of this design when compared to the previous designs is the lack of physical buttons. However, creating an iPod Touch case specifically designed for our program will solve this problem. Overall, developing an application for the iPod touch is the best design alternative.

Design Evaluation

In order to determine which design was best suited to our client's needs we constructed a design matrix (table 1). Each design was judged against five criteria. Ease of use is the primary motivation for this project, and as such, is weighted at fifty percent of the total score. Cost was rated at twenty percent and mass production, ease of manufacture, and data storage/processing were each worth ten points out of one hundred.

Design one scored the highest in ease of use. This was because design one went beyond the increase in button size and menu simplicity provided by designs two and three. The focal length of the magnifying glass could be tailored to each patient, making it easy to custom fit design one to the needs of the individual user.

However, improvements in screen viewing were not substantial enough to offset the impracticality of manufacturing such a device. In the end, the data storage and mass distribution capabilities of design three secured its place as our preferred design alternative.

Design	Ease of Use (50)	Cost (20)	Ease of Manufacture (10)	Mass Production (10)	Data Storage/ Processing (10)	Total (100)
1	47	10	0	2	3	62
2	43	14	5	4	3	69
3	43	15	6	10	7	81

Table 1 – Design Matrix

Future Work

The current design of our prototype adequately meets all of our client's basic requirements. However, we would like to make some additions to the application that will benefit both our client and her patients. We hope to modify the application to incorporate a feature that stores the frequency and the duration that each song is played. Complementary to that feature, we hope to put together a survey that the patient will respond to following each track that is played. This survey will ask them to rate their pain/discomfort level before and after listening to the therapy track. Combined, these two additional features will give our client considerable feedback regarding which therapy tracks are producing the most successful results in reducing the pain of the patients.

Our prototype has yet to undergo testing by an actual cancer patient. We are planning to conduct several tests that will allow us to observe how the patient responds to the button size, button layout, menu to menu navigation, word size, and the external ABS case. Based on our observations, we can then adjust our prototype to better suit the needs of the patients.

Most importantly, we have yet to upload the application from the SDK onto the iPod Touch. This unexpected delay is due to Apple requiring us to go through a licensing process before we can download our application onto any Apple iPod. Furthermore, due to legal issues regarding song licensing of our client's therapy tracks, we are also unable to upload the application onto the Apple Online App Store. Nevertheless, we hope that within the next few weeks we will gain Apple's permission to upload the application onto our client's iPod Touch directly from our computer (ad-hoc distribution), so that she may begin utilizing it in her research. We have emailed Apple's administrator on campus, and are waiting for him to respond so that we can set up a meeting and complete this project as soon as possible.

Conclusion

Now that our final design is complete, many benefits can be observed when compared to the previous means of administering relaxation therapy. Since the final design has a touch screen, the controls for the user has been upgraded from the difficult click wheel to large, easy to see buttons. The case assists the user in pressing these buttons by providing tactile feedback as well as guiding their fingers to the button and preventing unwanted selections. The final design also alters the menu format. Previously, the menu options on the iPod nano were placed in a list with little to distinguish the different options. Now the menu options are not only separated from each other by the case, but also different colors to make the program more intuitive to the user. Making the device larger is yet another benefit for this relaxation therapy. The buttons will be easier to press and the text easier to read. Furthermore, our client has told us that some of her

patients were intimidated the small size of the iPod nano. The external case we made gives the user something concrete to hold, while protecting the iPod inside.

Besides all of the physical improvements we did for our client, the greatest benefit of our device is that the program can be distributed to any iPod touch our client chooses. Though the main goal of this project was to give our client a better way of administering relaxation therapy, we carried out the design process with the goal of maximum reproducibility in mind. The final design of the program can be uploaded onto any iPod touch our client chooses, giving our design a much greater potential impact than any physical controller we could have built.

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[7] Mantes, Jon. "Technical Sketch of iPod Case." 2008.

APPENDIX A

Product Design Specifications
Development of a user-friendly MP3 player for older cancer patients

Team Members
Joey Labuz – Team co-leader
Michael Conrardy – Team co-leader
Derek Klavas – Communications
Jon Mantes – BWIG
Joel Webb – BSAC

Problem Statement
Our client's group is conducting a research study using recorded relaxation, distraction, and imagery exercises to help patients with cancer manage symptoms including pain, fatigue, and sleep disturbance. Research indicates that these strategies can help patients to achieve a personal sense of control over symptoms and diminish their severity. In today's busy cancer care settings, there is not sufficient staff or time to provide these symptom managements strategies precisely when and where patients need them. Their team has developed an intervention using recorded strategies, delivered on an MP3 player, so that patients can carry them throughout their day, and use the interventions whenever their symptoms become bothersome. For example, a woman with advanced ovarian cancer may use an imagery exercise to help control pain that occurs after walking, or a relaxation exercise to facilitate return to sleep, if she wakes with worries in the middle of the night. Because cancer is a disease associated with aging, many patients are elderly and are not familiar with common MP3 devices. Moreover, the elderly may have difficulty visualizing the small display screens / text and have fine motor limitations that interfere with operating small controls. In a recent feasibility study done by our client's group, older cancer patients said that they enjoyed learning to use the MP3 player and listening to the recordings, but struggled with managing controls (on / off / hold), and navigating between recordings and menus. Our goal is to develop an MP3 player that will be more user-friendly for these older patients. Other characteristics might also be built into the system including (1) the ability to monitor treatment 'dose' by logging specific recordings played, length of time they were played, and frequency of plays; and (2) the ability to enter and record numeric symptom severity ratings on the device before and after listening to each recording.

Client Requirements:

- Mp3 player capable of playing 12 relaxation exercises
- The browser and menu should be easier to use for patients
- The screen should be visible to people with slight vision problems
- The controls should be easy to manipulate for someone lacking fine motor skills
- The mp3 player should be able to accurately record "dose" (number of plays)

Design requirements

Physical and Operational Requirements

a. *Performance Requirements* – The device should be able to play songs for relaxation therapy and monitor frequency of use.
b. *Safety* – Volume restrictions should be implemented and the risk of electrocution should be considered.
c. *Accuracy and Reliability* – If the device records the frequency of plays it should be able to do so accurately.
d. *Life in Service* – The life of the device should be similar to the standard life of an ipod.
e. *Shelf Life* – The unit should not degrade while in storage.
f. *Operating Environment* – The device will be used in a clean dry environment at room temperature (hospital or home). It should be able withstand being dropped from a reasonable height (5 ft)
g. *Ergonomics* - The device should be easy to manipulate for someone who lacks fine motor skills. The screen should be easily visible to someone with impaired vision.
h. *Size* – The unit must be portable for patient use (footprint no larger than 25 in^2)
i. *Weight* – The device should weigh less than 2 lbs.
j. *Materials* – Non-magnetic materials and nothing toxic (i.e. Lead) should be used.
k. *Aesthetics* – Pleasant to touch, comfortable to hold, soothing colors.

Product Characteristics

a. *Quantity* – One Prototype
b. *Target Product* Cost – Under 250 dollars per unit.

Miscellaneous

a. *Standards and Specifications* – Patient confidentiality should be maintained.
b. *Customer* – Easy to navigate interface for clinicians.
c. *Patient-related concerns* – A patient should be able to use the device even if they are unfamiliar with current mp3-player technology.
d. *Competition* – We are not aware of any competition for a patient friendly mp3-player designed for hospital/therapeutic use.