# Designing Tangible Interaction

## — User-Centered Design for Music Players

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## ABSTRACT

My research investigates tangible interaction design potentials for music players. It provides background research on designing tangible interface for music players, as well as design activities of developing design concepts for my target users.

To answer the research question: how can we apply tangible interaction in music players to create ease-of-use and joy-of-use for users? I study products and target users. Then I have design activities to generate design concepts. Finally I involve users to evaluate the concepts.

Through my research through design process, I gain several conclusions for designing tangible interface for music players: (1) Study users to find out their experiences and requirements. (2) Refine and transfer ease and joy elements from user studies to create tangible interactions. (3) Evaluate the created interactions for better solutions.

## KEYWORDS
User-Centered Design, Tangible Interaction, User, Music Player

## 1. INTRODUCTION

### 1.1 Project Overview

#### 1.1.1 Project Motivation

With the development of modern society and technology, music players become one of the most popular IT products in our daily lives, and the booming information technology allows more and more functions to be realized in an integrated product. But when we talk about the user interfaces, most current general music players are still limited within numbers of buttons and screens, which may confuse users. The rich interactions between users and music players are lost. As Buur and Ørisland (2000) mention, "interaction designers in enthusiasm with new technologies fail to preserve or transfer the quality of use, which were achieved with outdated technologies". So we need a new breed of music player concepts to recall qualities of interactions.

The aim of my research is to employ user-centered design approaches to explore tangible interaction to create ease-of-use and joy-of-use in future music players. My task is to design tangible interfaces for very basic functions, which do not contain screens for feedback. It is about bodily interaction with physical objects, in tangible interfaces there are graspable and touchable things. The diversity of physical operations could enrich the usability of products. I believe that rich and meaningful actions can help users interact with music players easily and joyfully.

#### 1.1.2 Target Users

It is important that I know who my targets users are. "Designing usable interactive products thus requires considering who is going to be using them" (Preece, Rogers & Sharp, 2002). My research investigates design for young women going through the transition period from childhood to adulthood. The reason is that they are experiencing increasingly modern technological devices. As well Isomursu and Still (2003) say that "girls are a user group often neglected in the design of technical devices". Issues which I consider challenging with this target group are to explore how they interact with objects, as well to find out what kind of interactions meet their requirements.

#### 1.1.3 Research Question

My own studies of different music players have shown that successful interfaces should bridge high quality interactions between the users and the music players. I will explain this more detailed later. My research question is: how can we apply tangible interaction in music players to create ease-of-use and joy-of-use for users?

**Ease-of-Use**

In my research, ease-of-use aims at creating easily understandable music player interfaces for users. The interfaces should be easy to understand and incorporate intuitive ways of interacting. They may offer clear and easy following instructions. As well they can provide useful feedback in response to users' input. In my research, I will guide users to help me discover the elementary actions of operating a product, and then string them together in order to make complex adjustments. Since the actions in themselves are simple, they are required to bridge meaningful communications and interactions between users and music players.

**Joy-of-Use**

In my research, joy-of-use aims at creating enjoyable experiences for users to interact with music players. By certain tangible interaction, the music players can offer users comfortable environments and enjoyable medium, and let them feel involved and glad. Consequently, users are willing to interact with the interfaces. This can "invoke curiosity and stimulate exploration, keeping the interaction engaging and fun" (Djajadiningrat, Kyffin, Overbeeke & Wensveen, 2004).

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## 1.2 Heuristics and Approaches to My Design Research

### 1.2.1 User-Centered Design

I employ user-centered design approaches to achieve my goals. My user-centered design activities incorporate iteration and encourage a user focus. There are six phases within my research through design process: (1) Literature studies are conducted to gain background knowledge of designing tangible interfaces. (2) Market overview and case studies reveal potentials for developing my preliminary design. (3) Evaluation of the preliminary design, continuous user workshops and user interviews for inspiring new concept ideas. (4) A series of concepts and physical prototypes are developed to represent tangible interactions. (5) User evaluations are performed to examine how the designs reach the goal of ease-of-use and joy-of-use. (6) Conclusions upon the research through design process, preparation of starting the next iterative design process.

### 1.2.2 Interaction Design

Interaction design is widely discussed in literature. The definitions are similar. The one best for my purpose is defined as "designing interactive products to support people in their everyday and working lives" (Preece, Rogers & Sharp, 2002). In my research, it is about enhancing and extending users' experiences. My central concern of interaction design is to develop interactive music players that are usable: easy to operate, effective to use and enjoyable to experience.

### Tangible Interaction

It is quite hard to provide an accurate definition of what tangible interaction is, because it is still a rather young field within interaction design research. A look through the literature shows that researchers have quite different views on what makes interaction tangible. Some studies focus on the potential of tangible interfaces to control and represent virtual data (Ullmer & Ishii, 2000). For example, Ullmer, Ishii and Glas (1998) describe that the physical blocks are used to control and represent data. While Buur, Djajadiningrat and Jensen (2005) view tangibility as "a means of making information inside the computer manipulable through the interaction with physical objects outside it". In my research I go for the second definition, because I think people do too much works based on computer screens. They could be better served "if we would return to control through physical objects, to real knobs, sliders, buttons, to simpler, more concrete objects and actions" (Norman, 1999). In this context, tangible interaction is about bodily interactions with physical objects: in tangible interfaces there are graspable and touchable things.

### 1.2.3 Design Principles

There are many design principles of user-centered design that can enrich interactions. I will bear in mind some of the most crucial ones when I develop concepts and prototypes.

### Convention

Usability first website describes conventions "are de facto standards, established not by the dictate of authority, but through implicit agreement and imitation". I think conventional product operations can help users recall previous learnt experiences easily and quickly. Users may make fewer or no mistakes, because similar tasks ought to have similar input interactions according to their knowledge. It is "arbitrary, artificial, and learned. Once learnt, it helps us master the intricacies of daily life" (Norman, 1999).

### Affordance

Donald Norman (1990) describes affordance to include "cultural and social constraints", he used the term "perceived affordance" in the field of interface design to mean the actual properties of an object that can be perceived. Here are some examples. A knob, by the round shape and the cyclic arrows on its surface, suggests the idea of rotating it. A bottle, by the size and the curvature, suggests grasping it. A bed, by the figure, the material, the position, suggests lying down on it. A ringing telephone suggests an incoming phone call and demands attention. When I explain that an object contains affordance I mean "to say that we have learned that it has a particular use or it works in a particular way" (Oshlyansky, Thimbleby & Cairns, 2004). Affordance provides users with indications of how to operate objects properly.

### Feedback

My music players should perform clear feedback to respond and insure users' proper input interactions. For example, when a user acts to switch songs, the player must not continue playing the same song or wait for a long time to respond, it has to start playing another song immediately. So users can be confident to use the products without any confusion.

## 2. BACKGROUND RESEARCH

## 2.1 Market Overview

In this section, I introduce general music players in the market. Then I show the iPod music players and explain why their interfaces are advanced than the general ones.

### 2.1.1 Music Players in General

In the current market, when talking about music players, people always have a clear picture in their minds what the general ones look like (Figure 1). These music players are largely produced to fulfill the market. They have standardized buttons and screens on the user interfaces. Though users can easily remember the ways of use by previous experiences of using tools in their daily lives, the music players loose rich interactions with users. Because they limit input interactions within monitoring screens and pushing buttons, which are not tangible. For example, when a user wants to get music, he needs to push the play button. When he wants to stop playing, he needs to bush the same button again.



**Figure 1: Music Players in General**

### 2.1.2 The iPod

In the last few years, Apple Computer, Inc. (Apple) developed several new music players, such as iPod 4G, iPod shuffle and iPod nano. Their user interfaces are much advanced. Most modern iPods have the "Click Wheel" which can "put music under your

thumb" (Apple). Through users' actions on the wheel, it functions forward, rewind, play, pause or access menus. It uses the "touch-sensitive surface" to adjust volume or select music. Although the iPod shuffle does not have the touch-sensitive surface, all the operations are within the thumb input interactions. Users can operate all the functions without looking at it. The wheels have high interaction qualities. The universal icons on the surfaces give users common understandings of the functions. The round shape and the size provide users with clear indications of the operations. And they are tangible for users to interact with.

Through the consistent refinement and development, I think the iPods are more attractive and multifunctional than the general music players. Because they "generalize and abstract" (Conley, 2005) an identical form for product interface over time (Figure 2), I think the form creates a cognitive understanding and a convention of user experiences.
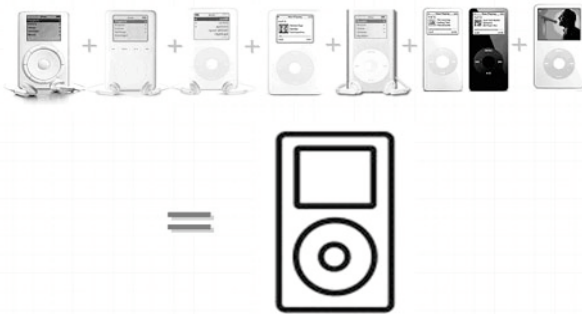

**Figure 2: The iPods' identical user interface**

## 2.2 Case Studies

### The DPPi2005 Workshop – 2005.10.25

Technische Universiteit Eindhoven held a conference on Designing Pleasurable Products and Interfaces (DPPi2005) in October, 2005. As an interested student and a volunteer, I facilitated and participated in the design-day workshop of the conference. The aim of the workshop was to design, build and evaluate dozens of different new music players. All the participants were divided in teams and every team designed a tangible music player. The teams invented new ways to select, play or listen to music. All the teams started creating a persona with a specific personality. Based on this persona, we formulated and visualized a vision for the music player. We had to build working prototypes by technologies. "The way we think and perceive technology also steers and influences the products that we created" (Verbeek & Kockelkoren, 1998).The workshop equipped each team with a computer, a sensor board, sensors, actuators, software and an assistant, which allowed us to make a working prototype. At the end of the day, we evaluated each other's music players. In this section, I select three final working prototypes related to my design research. Each of them has different values and input interactions.

### The "Mister M."

The "Mister M." music player is a multifunctional device (Figure 3). It is designed based on a solid user interface. The "Mister M." has two buttons and a display in the middle. It matches with two colors that are silver and black. It is portable according to its handy size. When a user wants to start the music, he needs to turn one of the buttons on the right hand side. For the same button, if

he turns it clockwise, the music player will play next song. Vice versa. For the other button on the left hand side, if he turns it clockwise, the volume will be turned up. Vice versa. The display of the "Mister M." not only allows user to monitor the music player, but also allows user to browse visual information of the songs, such as the CD covers, the webpage and the pictures of the artists. But the display function is not realized in this prototype.
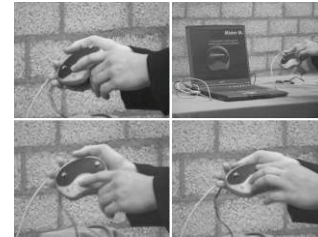

**Figure 3: The "Mister M."**

### The "Cube" Player

The "Music Cube" is a music device that is used at home (Figure 4). The shape is a cube. It is designed for a musical user who enjoys "easy-listening music", not "frightening music". The music player has a string and six outer surfaces. One of the surfaces is blank. Five of them are inserted with pictures of user's own situations in his life, and the pictures can be substituted. How can a user operate the "Music Cube"? For example, when a user is having dinner, and he sets the surface of dinning activity picture on top, then the music fits his dinning social kind of events. If he wants to adjust the volume, he needs to pull the string to control the volume become louder or softer. If for some reason the user does not like the music any more, he can shake the cube in order to change music within the certain event. When the user sets a different surface on top, then he gets a different kind of music. If all the pictures do not fit a special activity, the user can write down the names of the music and the artists on the blank surface, then the device searches the music from the local computers and the internet music stores, so that he can get the special music for the special events.
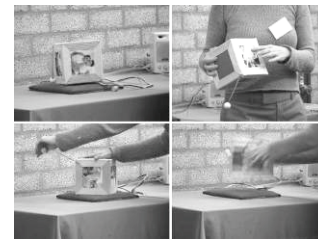

**Figure 4: The "Cube" Player**

### The "Gun" Player

The "Gun" music player looks like a gun (Figure 5). Its main function is to select songs. The idea generally comes from action movies of the cowboys in the western America. The music player traces back the cool feelings of playing with real guns, it aims at letting users feel confident and special. It is composed of two parts, a "gun" and a holster. The "gun" body is made by two pieces of wood, one overlaps the other, and they are fixed by a rotatable accessory and equipped with sensors. When a user wants to start the music, he simply takes the gun out of the holster, and the "gun" starts playing. If the user wishes to switch songs, this is the time for him become a cowboy. He needs to hold one piece of

the wood and spin the other. The directions of clockwise and counterclockwise indicate selecting next song and the previous song. Moreover, when the user continues spinning the "gun", it will jump to the songs in his play list according to how many times he spins the player. When the user closes it and puts it back into the holster, he chooses the action to stop playing.



**Figure 5: The "Gun" Player**

**Conclusions of the Workshop**

Conventional interfaces of music players give users a common understanding. Users can rely on their previous experiences to operate the general music players without any difficulties, the "Mister M." is a good example. But when they face with new music players which do not have conventional interfaces, they may feel confused. Users need to figure out certain actions to run the devices. When a certain form suggests correct actions, users would follow the correct actions to realize the desired functions. This can make ease-of-use and joy-of-use experiences. "Affordances specify the range of possible activities, but affordances are of little use if they are not visible to users" (Norman, 1999). Therefore, designers have to ensure that the desired and proper actions can be easily perceivable. When a certain form does not convince users to interact confidently with products, incorrect operations may easily occur. So clear affordances of music players are the crucial elements which can help users clarify the actions. For example, the "Music Cube" does not have a traditional button to adjust the volume, but it provides a string with two small wooden balls at the ends. The form of the string suggests pull action. When users pull the string, the volume is adjusted. Affordance is important when the convention does not work out. It gives users indications of how to operate the music players properly.

As showed in the workshop, the "Gun" player does not have conventional user interface, instead it applies an interesting and tangible way for its operation. The future music players do not have to maintain the forms of the general ones. They can break up conventional elements and make user interfaces more tangible, so that there will be richer user actions within the music players. These kinds of user interactions may become conventions in the future products. For example, before the invention of the iPod series, the interfaces of the general music players limit themselves with several buttons and screens. Users need to push or turn buttons in order to operate a device. The iPods enable users to adjust volume and select songs by sliding a thumb on the "touch-sensitive surface". Users realize it is tangible and meaningful for them to interact with the music players. At the same time, more and more music players in the current market have the similar forms and functions. So, rich user actions can help form new conventions. As well the new conventions can also help users remember certain actions to operate the new breed of music players properly.

## 2.3 Preliminary Design

### 2.3.1 The "User Experience Design" Course

It was a design course held in Mads Clausen Institute in the fall of 2005. The purpose of the course was to develop MP3 player prototypes, aimed at creating the total, holistic experience that interaction concepts would offer in use. And the prototype interfaces should not contain screens for feedback. Students had to create electronic prototypes through iterative user studies and evaluations.

### 2.3.2 The "Flower" Player

As an outcome of the course, my engineer partner Cong and I together developed a "flower" player (Figure 6) to meet the requirements. It was my first try to design a device for female users. My purpose was to build a tangible interface for users to interact, in order to create comfort and enjoyable use experiences.
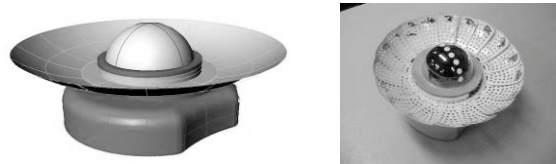


**Figure 6: The "Flower" Player**

The "flower" player is a stand-alone physical working prototype with the electronic stuff built inside. It is designed for female and home use. There are two main parts of the "flower": a bottom stand and upper petals. The interface controls two basic functions: adjust volume and switch songs. When a user opens the petals, it starts playing a random song. And the volume follows the open scale of the petals, which means the volume will get louder when a user continues to open the petals. Meanwhile, the lights inside the "flower" provide visual feedback of the volume status. When a user wants to switch songs, she needs to hold the petal and incline them left or right.

According to the design principals identified earlier, this prototype enhances tangibility of operating a device. It requires effective and meaningful input interactions. Users have to engage both of their hands to interact with the "flower" in order to realize certain functions. As well the "flower" provides instant feedback to respond and insure users' proper input interactions.

## 3. USER RESEARCH

### 3.1 User Evaluations for the "Flower" Player

Beyond the prototype development from the DPPi2005's design-day workshop, the design of the "flower" player paid much more attention on user engagement. User evaluations were not only performed in the end of the development, but also in the beginning and during the process. That was why the prototype received a lot of positive feedbacks from users. Here are the user evaluations of the concept prototype (Figure 7).

There were five users involved in this activity. All of them claimed that this design was for female users because of the color match, the smooth shape and the flower petals. Users found that the operation was very tangible and more advanced than pushing buttons, especially the open petals action. They stated that "the

petal movements were attractive and emotional, as well the functions can be foreseen". The shape of the player can suggest them to incline the "flower" in order to realize certain functions, and the action let them feel balanced. Users enjoyed playing with it, and they were interested in the way of getting music, because it was visual. Four of them said they would buy it if it was available in the market, because the player also looked like a sculpture which can merge into and decorate their home environments.

Users also contributed valuable suggestions to this design. First of all, they required more visible electronic lights from the "flower" to respond and insure their volume adjustment actions. Secondly, they suggested that it could be more aesthetic to build the bottom shape asymmetrically. Thirdly, they wished to have a click sound to confirm the on/off status of the player. Moreover, they preferred to add some advance functions on the petals, such as mode selection, fast-forward/back-forward and automatic petal open/close.
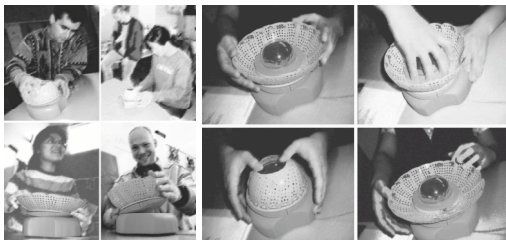

**Figure 7: User Evaluations**

From the result of user evaluations, I saw the "flower" music player was successful to create comfort and enjoyable use experiences. It engaged users by full hand interactions. It represented tangible interaction by a physical form without screens and buttons. To improve it, I learnt that I need more technologies to make it fully working, for example, add more electronic components.

## 3.2 User Workshops for New Ideas

### 3.2.1 User Workshop - 2006.02.02

The purpose of the workshop was to help me find out my design themes. It took place in a family apartment in Beijing, China. There were three young women invited to my workshop, they are 15, 18 and 24 years old (Figure 8). I run the workshop for two and half hours.


**Figure 8: Workshop Participants**

**Steps of the Workshop**

(1) Warming Up – I motivated the participants to move, stretch, shake and walk around with music playing. Participants warmed up to begin activities with fresh energy and motivation. After this, I explained the purpose and the stages of my workshop to them.

Object Sketching – I asked them to make sketches of objects they enjoyed using or felt inspiring in their daily lives. Later on they presented their sketches. Because of their nervousness in the beginning, I allowed them to discuss and peek at the others' drawings when they were sketching. This helped a lot to run the workshop smoothly. All of them drew modern home appliances that entertained them, such as loudspeakers, TV remote controls and ink printers. They claimed that they liked being relaxed because they were "pursuing easy life". As one said, "I always feel good when a product obeys my commands, as well amuses me".

Field Study Playbacks – I showed them edited video clips of the DPPi2005 and my "flower" music players, in order to let them get a bit familiar with tangible interaction design.

Brainstorm sketching – I asked them to brainstorm five rough music player concepts for the future use and to present their ideas (Figure 9). One interesting concept was called "flying ball" which has a sphere body with two wings. It can rotate on a table without falling down, when a user stretches the wings it starts playing music. When a user bounces it on the table, it switches songs. Other ideas focused on tangible inputs, such as buckling, twisting and coiling.


**Figure 9: Brainstorming Sketching**

Mood Collages – Finally each participant composed a mood collage to visualize her personalities and preferences (Figure 10). These collages reflected their own thoughts and expectations. The 15-year-old participant made the first one. She illustrated relax and romantic feelings because she had an "easy-going personality", as well she wished everything around her to be enjoyable. She chose the red and pink colors which she thought romantic to represent her ideas. The 18-year-old participant composed the second one. She was busy preparing for her collage-entry exam, so she wanted to have everything fresh and easy to manage. The third one was made by the 24-year-old participant who worked in a government office. She loved decorating her house with lovely items because she wanted to be surrounded and amused.
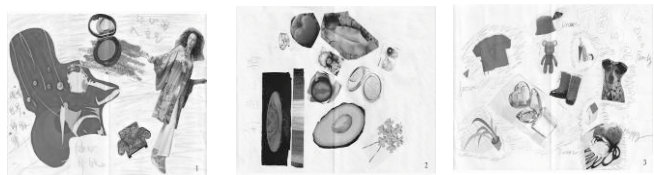

**Figure 10: Mood Collages**

**Conclusions of the Workshop**

·Let users have joy-of-use experiences.

·The music players should look attractive and interesting, because users want to get amused.

·Let users feel proud, confident and romantic when they interact with the music players.

·The size, materials and colors should provide users with comfortable feelings.

### 3.2.2 The SIDeR'06 Workshop - 2006.02.25

This workshop aimed at involving young designers to inspire new concept ideas for my future music players design. It took place at Chalmers University of Technology, Gothenburg, Sweden. And it played a part of the 2nd Scandinavian Student Interaction Design Research (SIDeR'06) Conference. The set up of my workshop was walk-in format in an open hall. Interested people can get close to my desk and join the discussion (Figure 11). I run the workshop for one hour.


**Figure 11: The SIDeR'06 Workshop**

I hung several illustrations of the music players that I had studied on a wall. I also lay a computer, some rough prototypes, pens and papers on a desk. When I started playing video clips from my background studies, five people came to ask what it was for. I concisely explained the aim of this workshop and my research. Then three more people joined. First, I showed them the user studies and the video clips. They enjoyed watching the video clips very much. And we discussed how we can improve these concept prototypes. Secondly, we took a look at the rough prototypes and illustration that I provided and started discussion. Our discussion focused on exploring possible design schemes, we related design schemes with our familiar and interested topics, such as nature, technology and culture. As an outcome, we agreed on looking into nature context because some of the natural elements were attractive. Finally, I asked the female participants to sketch some favorite object forms (Figure 12). Each of them drew her sketches with intuition and without discussion. Three people looked into nature context, especially the streamline shapes, such as the curve of a feather, the spiral of a nautilus, the bend of a leaf and the stretching of a bird. Other people looked into different aspects, such as hat fashions, favorite foods and toys.


**Figure 12: Form Sketching**

**Conclusions of the Workshop**

·Do more user studies to discover the common needs from target users.

·Consider the material and color matches to enhance product usability.

·Keep an eye on nature and streamline forms, try to jump out of symmetric shapes.

·Find and follow fashion trends in the design.

**3.3 User Interviews**

Interviewing and observing a group of my target users can bring me a broad view of the context, which contains the people and the objects. The aim is to understand users' experiences, and what makes a music player easy and joyful for them to use.

**3.3.1 User Interview 1 - 2006.03.06**

Heidi is 19 years old. She is a college student in California, USA. Currently she is traveling in the north of Denmark. She loves traveling around and doing sports, she always feels confident and energetic to face new things.

Heidi usually listens to solo music when she is alone at home, and she does not want anybody to disrupt her. Music lets her feel relaxed when she is tired from traveling or doing sports. Although she has a MP3 player with her, Heidi does not think it is a good way of enjoying music. Because the earphones always make her ear feel uncomfortable, as well the sound quality can not reach her requirement. She prefers getting music from loudspeakers. Also she mentions that "I do not desire a portable device with me, but maybe a high quality home theater".

Heidi has been playing guitar very often since she was a high school student. She learnt it by herself and she often practices at home. She enjoys getting melodies from her physical actions, not only push a play button on a device then lay on a bed. "Everything is under my control, also there are a lot fun when you generate music by yourself", she says.

**Conclusions of the Interview**

·Make users dominate music play, let users feel free to interact.

·Use loudspeakers or new ways instead of earphones.

·Integrate fun elements into physical actions.

·Apply some input interactions from existing music instruments.

**3.3.2 User Interview 2 - 2006.03.12**

Stine is 23 years old. She comes from Århus, Denmark. Currently she is working as an interaction designer in Struer, Denmark. In her spare times, she enjoys watching TV, walking in the nature and going to concert. Since Stine started playing piano from five years old, she particularly enjoys "in-door" music. She listens to music everyday at home, as well she wants to share her favorite music with her friends.

Stine has a MP3 music player, but she rarely uses it. Because there are lots of buttons and too many functions, which always confuse her. Even most of the functions are not useful to her, such as recording voice, managing file folders and reading lyrics. She often uses it to store digital files instead of listening to music. The player requires a cable to connect with computers, this always makes trouble to her when she can not find the right cable. As well she thinks it is not fun to play with it. "Not only I want to get fun from the music, but also from interacting with my music player", she said.

Stine wishes to own a "home use" music player that does not have complicated user interface, as well the one can connect computers directly. She believes it can be interesting to transfer some hand actions to the input interactions, because she does not want to miss the fun part from both music and the ways of getting music. Stine drew some of the frequent and preferred hand actions in her daily life (Figure 13). She said that "the way of using a key to open my mail box is far more tangible than using a mouse to

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log in my email box". As well she said that "the scissor is like a tangible bridge or medium between me and a paper, simple, efficient, even it is playable".
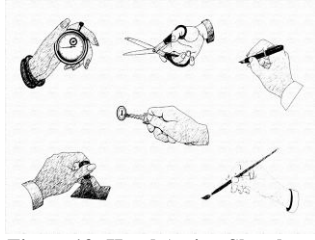

**Figure 13: Hand Action Sketches**

**Conclusions of the Interview**

·Consider designing music players for home use.

·Apply wireless technologies to develop future music players.

·Keep the user interface simple, clean and functional to reach ease-of-use.

·Consider the fun ways of getting music to reach joy-of-use.

## 4. DESIGN ACTIVITIES

### 4.1 Design Tasks

The previous illustrated case studies, preliminary design and user studies helped me define my design tasks. In order to address my general research question about tangible interaction, ease-of-use and joy-of-use, I developed a series of music player concepts for young women. The concepts were generated from those previous studies. I decided to focus on the very basic functions for each concept. These prototypes should have tangible interfaces, which do not contain screens for feedback. Along the way of my research, I realized that there were much more useful gestures and interactions besides the grasp action. Users need to interact with different music players by different tangible rich input interactions. I will explain the interactions that I found in my user research, as well I will show how I use them to develop concepts.

From my user studies, I found out that home was very important for young women. Because most of the users I studied said that they often listened to music at home. As well most of them were fond of home appliances. For example, all participants in my first user workshop drew modern home appliances when I asked them to sketch joyful and inspiring objects. The young woman in my first user interview argued that she preferred to have high quality sound from loudspeakers, as well the other young woman in my second user interview enjoyed "in-door" music. Therefore I thought mobile music players may not be feasible to meet their requirements. So I decided to develop music player concepts for home use.

To develop concepts and prototypes, I will bear in mind the design principles which described in the first chapter. These principles can strengthen interaction and usability of my concepts.

### 4.2 Initial Concepts

By refining users' requirements through the previous research, I developed four initial concepts that aimed at creating tangible elements to offer ease-of-use and joy-of-use for young women.

### 4.2.1 Touch & Tone (Figure 14)

This concept aims at providing users with a playable experience. Users can touch it and change its form. It has stretchable surfaces, it is stuffed with soft materials and electronic sensors inside. Single tones can be generated from simple user hand inputs, such as pressing, squeezing and pinching. There are no limits to make finger practice. So feel free to touch it and get tones!
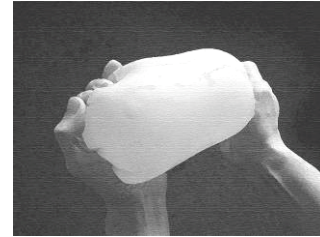

**Figure 14: Touch & Tone**

**Origins of This Concept**

It origins from users' general requirements, like simple interface and free to interact.

**User input Interactions**

All kinds of hand actions that can change the player's physical form.

### 4.2.2 Roll Me Up (Figure 15)

This idea makes users dominate music play. A user needs to continuous roll the handle to get continuous music. That means she can get music as long as she does not stop rolling the handle. She can pat the player to get a random song.
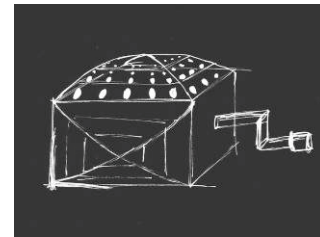

**Figure 15: Roll Me Up**

**Origins of This Concept**

It comes from my first user interview. It provides use experiences of "generate music by yourself".

**User input Interactions**

Roll, pat, hold…

### 4.2.3 Compass (Figure 16)

This concept focuses on music browsing of a music player. Its top part stays on the bottom part steadily because of the gravitational balance. As well the top part can do rotation centered on the bottom part. Rotation represents browsing music in this idea, users can rotate the top part to browse desired songs and pat it to start playing.
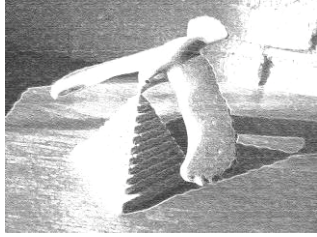
**Figure 16: Compass**

**Origins of This Concept**

It is developed from the "flying ball" concept in my first user workshop. As well it adopts the natural elements discussed in the SIDeR'06 user workshop.

**User input Interactions**

Push, pat, hold, flip…

### 4.2.4 Pop Eyes (Figure 17)

This idea aims at enriching users' hand input interactions. It is composed by three parts, a body and two soft spheres. It is hanging from a ceiling by a rope. If a user pulls it, it starts playing. If she wants to switch songs, she needs to shake the player. Then it plays a random song. If she wishes to increase volume, she needs to squeeze the spheres by both hands. She needs to cover the spheres to decrease volume. If she pulls the rope again, it stops play. The player provides feedback to each user input by visible lights sparkling inside the spheres.
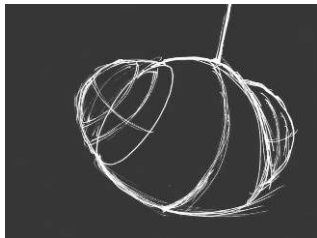

**Figure 17: Pop Eyes**

**Origins of This Concept**

Its form comes from users' preference and recommendations, like smooth shape. Its interactions come from users' frequent and preferred hand actions, such as squeezing, pulling and shaking.

**User input Interactions**

Shake, pull, squeeze, cover…

### 4.3 User Workshop

**User Workshop – 2006.04.10**

The purpose of the workshop was to assist me to improve and finalize the initial concepts. It took place in an apartment in Sønderborg, Denmark. There were four young women participants, who studied at local College schools. I run the workshop for one hour.

I showed them sketches and low-tech prototypes of my initial concepts to the participants. Then I explained my concepts and I asked for their opinions. As a result, three of them thought the "Pop Eyes" was the best. Because they said that its form looked very attractive, as well they thought the shake action was quite

emotional and efficient. There was a conventional link between the shake action and getting a new thing from their experiences. So they suggested using this action to switch songs for my final concept. The participants also suggested making the speakers visible so that they can know it was a music player. Then I directed the participants to look at the tangibility of the concepts. Two of them thought the "Touch & Tone" was their favorite, because they can play with it and get variety of desired forms. The other two claimed that they preferred the "Roll Me Up", because they were involved to create music, as well they applied "a different and innovative hand action to get music". Finally, I asked further suggestions from them. All of the participants mentioned that it could be nice to perform some tender actions to operate the music players. The balance feeling of the "Compass" was good, but it did not mean so much to the function. It could be better to add a "fun part" to involve users to dance with music.

**Conclusions of the Workshop**

·"Attractive things work better" (Norman, 2004).

·Make the speakers visible.

·Reassure a fun way which can invite users to enjoy the music is needed, add a "fun part".

·Use the shake action to switch songs is a good idea.

·Take along and refine more tender input interactions.

### 4.4 Final Concept

After refining the initial concepts through the user workshop, finally I developed a design concept and turned it into a working prototype. The interactions of the concept focus on basic functions, such as play/stop, adjusting volume and switching songs. As well the interactions originate from my previous studies, there are links between my research and the final design concept. I assume all the interactions I used fit for my target group's requirements and the concept's operations.

The form of the prototype is simple and clean, because I want users to focus on the interaction side of my prototype, rather than its appearance. As well the prototype is embedded with electronic components inside, so it can provide users with real feelings.

**The "Dancer"**

**First-Round Sketches (Figure 18)**

This concept aims at creating ease-of-use and joy-of-use experiences to my target user groups. It is composed by two main parts, a main body and a top "dancer".

The main body includes exterior, two speakers and volume control areas. The form is simple and clean. It provides clues to help users figure out how to operate this music player.

The top "dancer" is an active stick. It jumps up and down rhythmically accompanying the music. As well the "dancer" could invite users to dance themselves rhythmically. It can be the "fun part" when users enjoy music, users can look at it and dance with music.
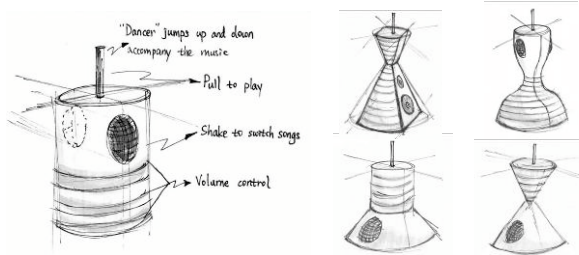
**Figure 18: First-Round Sketches**

## Second-Round Sketches (Figure 19)

There are a lot of shape possibilities of the main body as showed on both first-round and second-round sketches. I choose the simplest form which is a basic cylinder, because my choice is based on the interactions between a music player and a user, form should serve interactions and functions. So I think a simple and clean form is the most appropriate one for ease-of-use.

I change the top part from an active stick to a half sphere transparent cover with several small objects trapped inside. They also can jump up and down rhythmically accompanying the music, users can look at it and dance with music. The change can make the joy-of-use more visual.

I finalize the two volume control areas as waterfall looking. The curves provide attractive looking and smooth transition. Users can distinguish the two areas on the main body clearly.
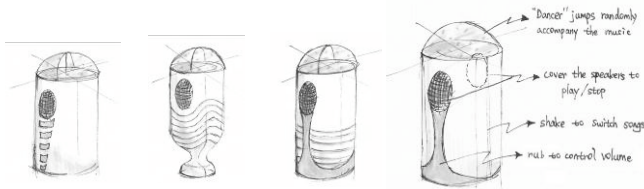


**Figure 19: Second-Round Sketches**

## Interactions of This Concept

There are three main functions of this concept: play/stop, switching songs and adjusting volume.

To interact with the music player, a user needs to cover the two speakers by both hands to start playing a random song. If she covers the two speakers again, it will stop playing.

When a user wishes to switch songs, she needs to shake the music player. Then it will play a random song from its play list.
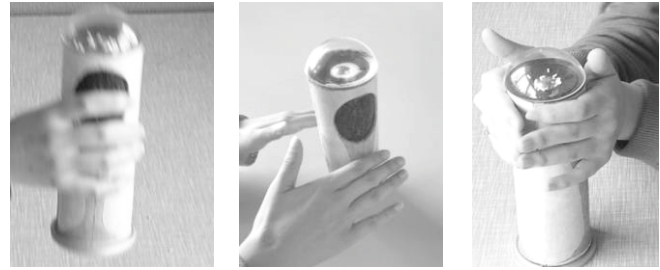
In order to increase volume, a user needs to touch the blue areas on the main body by both hands while rub upwards. In order to decrease volume, a user needs to touch the blue areas on the main body by both hands while rub downwards.



| **Stand By** | **Start Play** | **Increase Volume** |



| **Switch Songs** | **Decrease Volume** | **Stop Play** |

## Origins of This Concept

The shape of the main body comes from users' general comments, they want it to be simple and easy to interact. The form of volume control areas origin from the SIDeR'06 workshop, users want to have something related to nature. So I choose the waterfall idea, as well the "water" comes down from the speakers, it can represent the music volume function well. I also make the speakers visible compared with my initial concepts, because users think visible speakers can let them know it is a music device. This idea comes from my first user interview and my third user workshop. As an outcome of my user interviews and my third user workshop, there is a "fun part" on the top of the main body, it can amuse users and invite them to dance with music.

All of the interactions are originated from my user studies, I realize much more useful gestures and hand actions besides the grasp action. Specifically young women require some tender input interactions for operating music players. I adopt users' opinions and refine three tangible input interactions to this concept. I adopt the shake action to switch songs because most of my users claim that it represents getting new things. I refine the cover action to play/stop music because it indicates hands cover ears/speakers. It means wake me up, I want music. Or it means cover my ears, I want to be quiet. I refine the rub action to adjust volume because it is a tender way of adjusting heights on a vertical object. These interactions are important for young women, because they can provide users with clear hand input interactions according to their understandings.

## Relate to the Design Principles

This concept has two speakers on the appearance, users can recognize it as a music device according to their conventional understandings. As the shape of the main body is a cylinder and the size is fit for hands, users can get indications to grasp it. As the small objects dance in the top cover, they can suggest users shake the player to switch songs in order to get them remixed. The volume control areas can be easily recognized on the main body. They are not only the decoration, but also hint for users to rub following the curves vertically. This concept can also provide users with clear feedback. For example, when a user covers the speakers, it will start or stop playing immediately without delay.

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**Concept Illustrations**
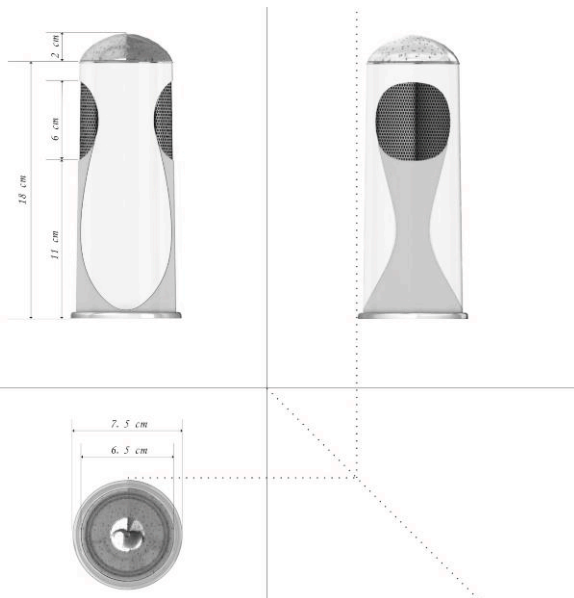


**Prototype Building (Figure 20)**

There are mainly two body parts and a transparent top cover in my prototype. I kept the form of my prototype simple and clean.

In order to make the prototype totally working, I built it with electronic stuff embedded inside it. I made circuit boards and connected them with a MP3 player circuit board, five light sensors and two loudspeakers.
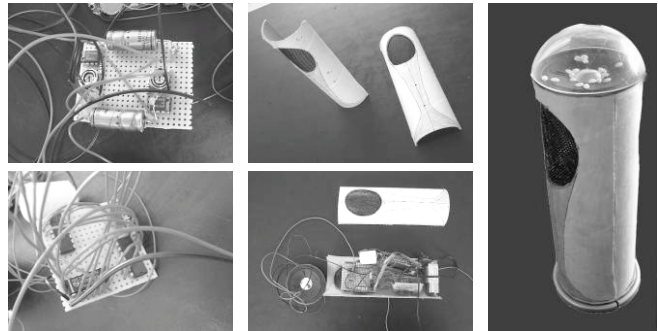


Figure 20: Prototype Building

# 5. EVALUATIONS

## 5.1 Company Visit

I visited a company in Denmark, it was one of the stakeholders of my research. The purpose was to examine how my research and final design concept fit into industry and market.

Jamo (Jamo) is a Danish audio company. Its mission is to "bring completely unique and memorable sonic experiences in your own home". People at Jamo have spent nearly forty years re-defining the state-of-art and developing in-house audio products that reflect their commitment to, as they themselves say, "outstanding technology, craftsmanship and design". They see themselves as suppliers of custom-designed entertainment.

I visited Jamo's headquarter in Glyngøre, Denmark. I was welcomed by Mr. Møller, Mr. Hald and Mr. Skjærbæk, who worked as respectively a project leader, a director and a user interface designer. They were interested in my user-centered design process, especially how I transferred findings from my user studies to my final design concept, because they can find connections. For example, Mr. Møller said "it is good you finalized a proper action to adjust volume, since you got the clues of tender actions from user studies and you continued to refine the rub action". They agreed that the interactions of my final concept were very tangible, the shake and rub actions let them feel fresh because these actions were different from the ones used in their products. To improve my concept, they suggested considering some added services and fitted systems besides individual products. Once it was put in the market, companies can have product series to work on, for example, music download web service. They also encouraged me to explore future home context trends because "it is a good idea to merge home appliances into home environments".

**Inspirations from the Visit**

·Consider combinations among individual products, services and systems.

·Explore future trends for home context.

## 5.2 User Evaluations for My Final Concept

The aim was to observe how users interact with my final prototype, so I can examine the feasibility of my concept. I focused on the interaction values such as operation, enjoyment and struggle. The evaluations were performed with six young women, ranging in age from 17 to 26. Each participant spent approximately twenty minutes with me to do an individual evaluation.

Each participant recognized the object as an acoustic device due to the two visual speakers. They understood that they had to figure out the "special ways" to turn it on, because "this thing does not have buttons for pushing" (Figure 21). Four of them thought it had something to do with the speakers to make sound, they tried to pat, knock and cover. As soon as they covered the speakers by both hands, music started. All four successfully found the correct input interactions within twenty seconds. They were surprised by this way of getting music: "I feel music suddenly jumps out of my fingers. I never imagined things can be controlled like this". As well they agreed that the cover action was more tangible and engaging than pushing buttons, it was easy to learn and remember. "It is easy to regard the two speakers as ears or sensors of the player, the cover action is very meaningful especially when I stop music". "Once I understand the action can generate music, I would think of doing this action again to cease music". The other two users had difficulties. Both of them focused on the top cover, they pressed, rotated and covered it. One finally managed to turn it on by acting the cover action to every part of the player. The other one gave up after one minute trying. This showed me that the actions are not totally obvious, however a music player can also incorporate learning. The playfulness of the concept let the majority of the users enjoy the music player. A possible improvement for the concept could be lights from the speakers to give clues, another idea is that the player can start playing music as soon as users touch it.


**Figure 21: The Cover Action**

All users believed that the music player was shakable, because they thought the small objects in the top cover suggested them do shake actions (Figure 22). Consequently, they found the switching song function: "Oh, it is interesting to shake music to search for my favorite songs", "All right, that is what I expected, it switches songs". The shake action was easily understood by users.


**Figure 22: The Shake Action**

Users struggled to find out how to adjust volume. They recognized the blue areas on the player, they all started by squeezing the two areas by hands. Then three of them considered rubbing the areas because of the smooth shape, so they can adjust volume (Figure 23): "It feels like touching my pet, the actions ought to be very tender". The other three did not work it out. They squeezed the areas all the time because "the outlines might be pressed to become curvier". To avoid misunderstandings, I think the volume control areas should strengthen their function identity by using softer even fur feeling materials, so that users can get clues to rub, not other actions.


**Figure 23: The Rub Action**

The top "dancer" brought all users joyful experiences. "It is interesting, see? They are jumping". By observation, I found that the player invited three participants to shake shoulders, two participants to dance and one participant to nod head. In order to invite all users to dance, I agree with one of their opinions that "if the whole player can dance with music instead of only the top part, there will be more fun and engaging".

From the evaluations, I conclude that the tangible interface of the "Dancer" successfully created ease-of-use and joy-of-use user experiences. On the one hand, users believed that the player was efficient to use, they can get feedback immediately. Also, the input interactions were "interesting and meaningful, they are easy to act and remember". Since all users agreed with the shake action and function, I thought this could be a convention for switching songs in my future music player designs. Users also thought it was safe to use because "this player is stand alone, there are no power cables". On the other hand, users got joyful experiences by physical interactions. They felt that not only the top part provided fun to them, but also the innovational ways of input actions, especially the cover action. All users claimed that this design was for female because its shape was clean, attractive and fits for hands, its functions were "simplified and adequate", and its operations were based on tender hand actions. Moreover, they stated that this design was mainly for home use because of its size. They wanted to merge it to their home environments. I consider it valuable to provide users with different player shape possibilities, so users can get customized and choose the proper one for their home context. Therefore I went back to my concept sketches and refined some easy-grasp shapes (Figure 24), I also kept the form simple, clean and easy to manage.
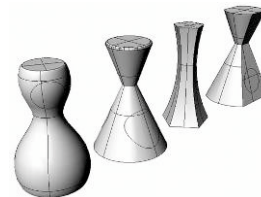


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**Figure 24: Shape Possibilities**

## 6. CONCLUSIONS

Through my research through design process, I am able to answer the research question: how can we apply tangible interaction in music players to create ease-of-use and joy-of-use for users? There are three solutions: (1) Study users to find out their experiences and requirements. (2) Refine and transfer ease and joy elements from user studies to create tangible interactions. (3) Evaluate the created interactions for better solutions.

User studies are crucial in my research. They provide me with detailed information of users' experiences and requirements, so I am able to find out what kinds of ease and joy elements they experienced and preferred by my observations and facilitations. User studies also let me get close to my users' living environments and understand their ways of thinking, therefore I can conclude some relative and useful tangible elements for my further design activities.

To bridge the user studies and the design concepts, I selected some easy and joyful tangible elements found in user studies, then refined them to proper input interactions, and finally transferred them into design concepts. These interactions should be meaningful to the product functions, so users can find out the correct ways to operate the product without difficulties. Furthermore, these interactions should be performed in some innovational ways, which can fresh users' conventional thinking and bring them joyful experiences.

The evaluation results help me verify applied tangible interactions and explore more tangible solutions. Ease-of-use and joy-of-use can be evaluated by users' comments and by my observations. If users are not satisfied with a certain interaction, they can give me input towards new requirements and suggestions. Then I can refine more possible tangible input interactions and find better fits based on the users' experiences.

These solutions lead my music players provide: (1) Tangible and novel user interfaces. (2) Simple and meaningful interactions. (3) Joyful and engaging user experiences.

## REFERENCES

Apple Website. (2005). Retrieved: November 10th, 2005, from http://www.apple.com

Buur, J., Djajadiningrat, T. & Jensen, M. V. (2005). *Designing the user actions in tangible interaction*. ISBN: 1-59593-203-8/05/008. New York: ACM Press.

Buur, J. & Øritsland, T. A. (2000). *Taking the best from a company history - designing with interaction styles*. Proceedings of the conference on Designing interactive systems: processes, practices, methods, and techniques. Page 27 – 38. New York: ACM Press.

Conley, J. (2005). *Trademarks, Not Patents: The real competitive advantage of the Apple iPod*. Retrieved: December 5th, 2005, from http://www.core77.com/reactor/12.05_ipod_trademark.asp

Djajadiningrat, T., Kyffin, S., Overbeeke, K., & Wensveen, S. (2004). *Freedom of fun, freedom of interaction. Interactions Journal*. New York: ACM Press.

DPPi2005 Website. (2005). Retrieved: October 22nd, 2005, from http://www.dppi05.id.tue.nl/

Jamo Website. (2006). Retrieved: March 28th, 2006, from http://www.jamo.com/

Norman, D.A. (1990). *The design of everyday things*. New York: Doubleday Currency.

Norman, D. A. (1999). *Affordance, conventions, and design*. Interactions Journal. Volume 6, Issue 3, Page 38 – 43. New York: ACM Press.

Norman, D. A. (2004). *Emotional design*. New York: Basic Books.

Isomursu, M., Isomursu, P. & Still, K. (2003). *Involving young girls in product concept design*. New York: ACM Press.

Oshlyansky, L., Thimbleby, H. & Cairns, P. (2004). *Breaking affordance: culture as context*. Proceedings of the third Nordic conference on Human-computer interaction NordiCHI '04. Page 81 - 84. New York: ACM Press.

Preece, J., Rogers, Y. & Sharp, H. (2002). *Interaction design: beyond human-computer interaction*. New York: John Wileys & Sons, Inc.

SIDeR'06 Website. (2006). Retrieved: February 20th, 2006, from http://www.cs.chalmers.se/idc/sider06/

UIImer, B., Ishii, H. (2000). *Emerging frameworks for tangible user interfaces*. IBM Syst J 39 (3 and 4): 915–931.

Ullmer, B., Ishii, H., Glas, D. (1998). *Media blocks: physical containers, transports, and controls for online media*. Proceedings of SIGGRAPH 98. Page: 379–386. New York: ACM Press.

Usability First Website. (2005). Retrieved: November 10th, 2005, from http://www.usabilityfirst.com/glossary/term_746.txl

Verbeek, P.P.C.C., & Kockelkoren, P. (1998). *The things that matter*. Design Issues, Vol. 14, Nr. 3 (Autumn), Page 28-43.