Math and Engineering Department

Wow!Objects

Presented to Universidade da Madeira for the Degree of Master

Paulo Sérgio da Silva Freitas nº 2030302

June 2008, Funchal

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Supervisor: Pedro Campos

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ABSTRACT

Nowadays computers have advanced beyond the desktop into many parts of everyday life and objects. To achieve this we have to make the computer invisible, and making a computer invisible is not a matter of size of the hardware, it's all about how the human perceives the computer. To make this possible, the interaction with the computer has to be done in an alternative way, such that the user doesn't notice the usual computer interfaces (mouse and keyboard) when using it.

Therefore this thesis focuses on physical objects that are interactive to achieve various purposes like persuasive objects for stress relief, persuasive objects to help the process of teaching, persuasive objects for fun, persuasive objects to display internet information and persuasive objects to make people feel more in community (exchange virtual emotions), persuasive objects are going to be created and evaluated to see if they have the power to simplify and turn our lives better.

The persuasive objects developed employ technology like sensors, actuators, microcontrollers, and computer/web services' communication.

This Master thesis starts by presenting a comprehensive introduction of what are persuasive objects and some general information about several areas that are related to our persuasive objects like stress relief, work experience, multimedia education and other major aspects. It continues by describing related work done in this area. Then we have a detailed view of each persuasive object and finally this thesis finishes with a general conclusion and notion of future work.

KEYWORDS: Ubicomp, interaction design, ambient persuasion, wearables, sensor-based installations, ambient intelligence, persuasive objects, physical computing, microcontrollers.

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I owe a great debt to Pedro Campos, the thesis supervisor who has given me the unique opportunity to work in physical computing and who has been very supportive throughout this thesis.

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People who supported me when it was needed, it includes friends and colleagues.

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Those who have helped me doing real world prototypes giving several technical support advices.

Thanks to all of you!

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1. INTRODUCTION

1.1 OVERVIEW

Recently we are facing the end of the dominance of the traditional computer because today computing is already embedded in more places than just our desktop computers/laptops. The digital will get in the physical space in a seamless manner and in a near future we will be expecting computing to be everywhere in everyday objects. So the terms physical computing, ubiquitous computing, pervasive computing, persuasive computing, ambient intelligence, tangible user interface, wearables and more recently everyware will get in our vocabulary as the term “desktop computer”. Some of these terms refer to the same things such as ubicomp, ubiquitous computing, pervasive computing and everyware.

Wearables are basically clothes and accessories. They’re something that we can wear and that uses electronics and computation.

Wearables have been being explored in various ways, such as shoes, t-shirts, bags, bracelets, gloves and others. They can use since LEDs to more sophisticated electronics parts (Bluetooth devices) that can also be controlled by a microcontroller. They can have several purposes, such as just for fun, for medical monitoring (EEG brain waves), for controlling other devices such as an “IPOD” with buttons or an accelerometer in clothes, for transmitting emotions in a new way, for marketing events and publicity. It’s a new world where the personal computer get’s of the desk and starts to “walk” with us in a future where most likely the computers will be all around us, in our clothes.

A tangible user interface is a user interface in which a person interacts with digital information through the physical environment.

Physical computing can be viewed as a creative framework for understanding human beings' relationship to the digital world and it refers the relationship between the hardware and software for an interaction with the ambient.

The term ubiquitous computing (ubicomp) is used to describe a smart space populated by intelligent devices that are embedded in that space.

The term pervasive computing is used to describe the integration between mobile computing and ubiquitous computing with the physical space that aims to enhance human life in a new and original way.

Mobile computing is a term that describes the ability to use technology while moving, some examples of mobile computers are the wearables, the smartphones and the computers installed in a car ("Carputer").

An ubicomp (ubiquitous) system involves some integration between computing nodes and the physical world, generally it uses everyday objects, and these objects are familiar to us, they look and act like we would expect them to, they have a physical use mode, they're in most cases screenless, no assumption that there's a text output, no expectation that they behave like us (not human) and that we're in control of the object (not superhuman). To understand how humans will interact with these systems is however largely unresolved and the best way to achieve it is by the observation of humans interacting with their environments including technology.

Ambient Intelligence is a research area that aims at embedding the real world with digital technology capable of predicting and adapting to the users' needs, in order to better fulfill those needs[1].

Persuasive technology is defined "as any interactive computing system designed to change people's attitudes or behaviors"[2].

If the ambient around us could adapt to our needs then our quality of life would improve because we would ideally be more productive, happier and less stressed.

This is the aim of ambient intelligence; it offers an environment where people are surrounded by electronic artifacts which are responsive to actions and presence of people. These technologies are expected to combine ubiquitous computing and intelligent systems and having humans as the centre of these technologies developments.

1.2 PROJECT SCOPE AND MOTIVATION

This project consists in persuasive objects aimed at multiple purposes (stress relief, educational, ambient displays of information and for fun) that supports the idea that if we could transform computer interfaces and outputs in something physical and use everyday objects to achieve that we could increase the life style/quality, reduce stress and get people to feel more happier and then getting better results in their lives.

Firstly, the idea was only to create persuasive objects for office stress relief but then we thought that we could design and create other persuasive objects that could help people in their actions/jobs without them noticing them too much therefore improving the quality of life. They also could act as stress relief in the point where if we improve the quality of life ideally the stress would decrease. Because almost everything nowadays can be stressful and if we had a better/different/innovating way of doing simple tasks with help of persuasive objects it would be great.

We could design a persuasive object for more than one purpose ate the same time. For example, teaching the alphabet to kids of about six years old can be a stressful job, they're noisy, they just want to play around and not be listening quietly to a teacher, so if we could develop some interface in a everyday object that would help them to learn the alphabet in a different way. It would be less stressful for the teacher and the kids would love it, they would learn the alphabet by playing with an object and not by the stressful/traditional way of being sitting around for five hours always thinking when is time to go home. It would be an educational object/interface for the kids who would learn by not noticing they were learning and it would also give more space/time to the teacher to evaluate each kid at each time, getting in the end a better learning method.

For the stress relief persuasive object in the office we used an alternative application area of persuasive objects, coined as "work style improvement persuasion". Broadly speaking, this includes any kind of persuasive object or ambient display that can improve the way people work at the office. Based on previous research on work styles, current research literature on ambient persuasion, and working prototypes under evaluation, this is a promising application area that should be handled by effective ambient persuasion installations.

So different kinds of persuasive objects, persuasive objects for stress relief, persuasive objects to help the process of teaching, persuasive objects to display internet information, persuasive objects for fun and persuasive objects to make people feel more in community (exchange virtual emotions) are going to be created and evaluated to see if they have the power to simplify and turn our life better.

The persuasive objects developed employ technology like sensors, actuators, microcontrollers and computer/web services' communication. They were primarily designed for educational/stress relief/displaying information/fun purposes but could be applied to other contexts and domains. In particular on using low-end, low-price computing, electronic and communication technology in order to identify solutions that could be economically deployed in some everyday artifacts to improve quality of life.

The persuasive objects makes extensive use of technologies like microcontrollers (Arduino[3]), interface kits like Phidgets[4] boards, distance sensors, LEDs, optocuplers, servo motors, LCDs, RFID tags and reader, magnetic and mercury tilt switches, Bluetooth communication, online data and internet servers to achieve this.

1.3 MICROCONTROLLERS, PHYSICAL INTERFACE KITS AND LEDS

To get physical and make cool interactive/persuasive objects we will need to go to another level and start making circuits and using microcontrollers and/or interfaces kits. They can also be used to act as an interface from the physical world to the computer (digital world) getting over the limitations of the traditional keyboard and mouse.

The microcontrollers (also **MCU** or **µC**) are small cheap computers used for sensing inputs from the real world and for controlling events (outputs) in the physical world. A microcontroller has memory on it, so we can develop programs to run in the microcontroller, without the need to be connected to a computer. They can also communicate (over serial port or over Bluetooth for example) with several devices such as a computer, a mobile phone and a lot more of them. There are different types of microcontrollers, higher level and lower level microcontrollers. The higher level

microcontrollers have a simple interface and generally no programming language, the lower level microcontrollers have a hard use, so we will have to design and implement the circuits and connect them to the inputs and generally the programming language is also a lower level programming language like assembler or C#.

Physical interface kits, as the name say are small interface kits with physical inputs and outputs that are connected to a computer, and the computer controls them generally over the USB port. The interface kits don't have any memory so we need to program in the computer and then use the API from that interface kit to control the inputs and outputs.

In our prototypes we use Arduino [3] microcontroller and Phidgets [4] interface kit.

Arduino [3] is an open-source physical computing platform based on a simple microcontroller board and it has a specific development environment for writing software for the board, the "Arduino IDE".

Arduino [3] can be used to develop interactive objects, taking inputs and controlling physical outputs. It can be connected via serial port to software on the computer (e.g. Flash, Processing, Python, C, SecondLife, Rubi.) or it can be stand-alone.

We will use three types of Arduino [3], the Arduino [3] Decimilia which has an usb port, Arduino [3] Bluetooth which has a Bluetooth module incorporated and Arduino [3] Lilypad which is smaller, wearable and it's washable (for wearables).

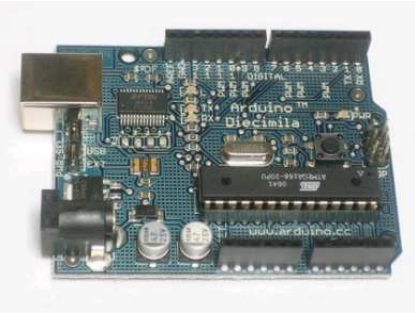

Figure 1 - Arduino Decimilia

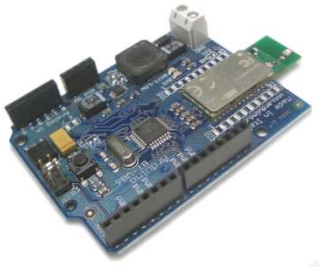

Figure 2 - Arduino Bluetooth

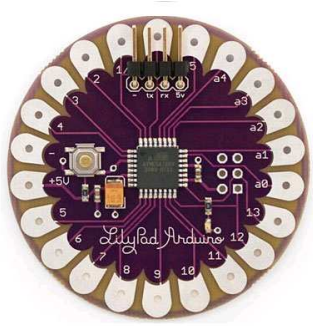

Figure 3 - Arduino Lilypad

Phidgets [4] interface kit, or physical widgets, is a tool that helps a developer constructing physical user interfaces without soldering or doing microcontroller programming so we can put together an installation pretty quickly. This interface is over USB and the installation/re-configuration is "plug and play". It has a free software library to interface with a lot of applications/development environments (e.g. Visual Basic, C/C++, Java, ActionScript 3). In our prototypes we will use Phidgets [4] interface kit 8/8/8 (8 digital inputs, 8 analog inputs and 8 outputs) and the Phidgets [4] RFID (reads tags brought within 3 inches of the reader).

Figure 4 - Phidgets interface kit 8/8/8

Figure 5 - Phidgets RFID

In our objects we use a lot of LEDs (***l**ight **e**mitting **d**iode)* that are an electronic device that lights up when electricity is passed through it. The two wires extending below the LED indicate how the LED should be connected into a circuit. The negative side of an LED lead is indicated in two ways, by the flat side of the LED and by the shorter of the two wires extending from the LED. LEDs can be operated on almost any voltage as long as they are used with the proper current limiting resistor. Normally a LED requires a forward voltage of around 2 Volts and consumes a current of about 20 mA. Using LEDs on high voltages without an appropriate resistor will probably burn them out. Higher brightness LEDs and specialty LEDs may require higher voltages and currents. To calculate the resistance use Ohms Law:

$$\text{Resistance} = \frac{\text{Supply Voltage - Voltage of the LED}}{\text{Current of LED}}$$

Also knowing that Phidgets [4] interface kit has a 300ohm internal resistor in each output we don't need to connect any resistor to attach LEDs to it, in Arduino [3] we have to use resistors in each output pin to use a LED so we won't be burning it.

1.4 UNDERSTANDING THE WORK EXPERIENCE

One of the key problems in today's fast-paced work experience is: interruption. Gloria Mark and colleagues present data from detailed observation from 24 information workers that shows that they experience work fragmentation as common practice [5].

Through extensive observation, they were able to discover issues like the fact that most internal interruptions were due to personal work, while most external interruptions were due to central work. Using empirical sampling methods and qualitative interviews has been also considered useful for examining attitudes toward availability and interruption [6].

We are all familiar with work-related horror stories. Psychologists have studied the human behavior in the workplace, in particular how attitudes can change through persuasion and the costs of stress at the workplace [7]. As a result from extensive psychology research, which has started many years ago, people now dispose of a large number of principles on how to deal with stress at work.

There is a huge potential for improving the human work experience by using ambient persuasion technology, and by carefully studying some of the principles for dealing with workplace stress.

1.4.1 AMBIENT PERSUASION FOR STRESS RELIEF AT THE OFFICE

Hans Selye[8] was one of the first to popularize the concept of “stress” back in the 1950s. Since then, psychology as well as medicine and popular culture have accepted stress as a negative fact of life. One of the techniques for relieving stress is known as the “Pilot in command” technique. Pilot training involves coping with emergencies. In face of those critical situations, physiological changes occur, which encourage a narrow focus of attention on the “blood rage” necessary for survival. In a crisis, however, a pilot needs precise hand and foot movements, not gross physical strength, and he or she needs clear thinking, not the tunnel vision of rage. As a consequence, the “natural” survival skills triggered by an emergency can actually lead to a pilot losing control of the aircraft.

Therefore, some of the stress-relieving techniques that are based on this example involve (i) taking command of breathing, (ii) taking command of muscle tension, and (iii) taking command of cognitive processes.

Taking command of breathing – we believe – is a situation that happens very rarely at the office. The need to take command of muscle tension is unfortunately much more frequent, as Repetitive-Strain Injuries (RSI) become more and more frequent. Regarding (ii), simply being *aware* of which muscles are tense is already half-way to reducing potentially stressing situations. We argue that ambient persuasion displays could exploit this. Also, letting go muscle tension is the key objective. Again, we argue that ambient persuasion interactive installations could be used for stimulating muscle exercise.

Being aware of (iii) implies changing focused, negative thinking and self-defeating thoughts towards open, positive thinking and intuitive creativity. Again, this argues that interactive objects and ambient persuasion should strive to achieve this goal.

1.5 MULTIMEDIA LEARNING AND RFID

Today we have various methods of learning, not just by the traditional way but now with the help of computers and multimedia.

An article[9] from Lawrence Najjar in which he analyzes multimedia learning and if it can help people to learn more quickly than traditional methods (in which he has taken various other studies in consideration that says that people generally believe that multimedia helps them learning) will be our orientation for an educational persuasive object (Wow!ABC).

He has concluded in that study/article that:

> *"This examination of a wide variety of empirical studies shows that multimedia information helps people learn sometimes. Computer-based multimedia instruction may help people to learn more information in less time than traditional classroom lectures. This is especially the case when the computer-based multimedia instruction is interactive and learner paced. The learning advantage for redundant*

> *multimedia over "monomedia" is not consistent. But this inconsistency is resolved when one takes into consideration the specific circumstances in which the media are presented. In particular, there is empirical support for concluding that multimedia information is most effective when:*
>
> *1. It encourages the dual coding of information.*
>
> *2. The media clearly support one another.*
>
> *3. The media are presented to learners with low prior knowledge or aptitude in the domain being learned.*
>
> *There is some empirical support for using specific multimedia to help people learn specific kinds of information. These advantages appear to be due to the ability of certain multimedia combinations to support the way people understand, organize, and access the information". [9]*

And another study [10] done by our colleague Rubina Freitas for her master thesis supports the idea that multimedia can help the process of learning, as she has concluded:

> *"By the tests that we have done, we can see that technology, in this particular case with Augmented Reality, can help increase the motivation and student's learning. It was found that the effect of using SMART is much higher among weaker students, although the most part of students that tested it, liked to use it, which shows a very high level of motivation. The weak and average students are those who are more influenced by the use of AR, which shows what Gardner said, that despite all have different intelligences, not all developed them the same way or nor in the same proportions. Therefore, these students are students who did not develop both the linguistic intelligence, but, developed for example, the spacial intelligence." [10]*

Radio-frequency identification (RFID) is an automatic identification method and it has the potential to revolutionize the way goods and other objects are identified and tracked. When this potential is considered in the context of helping the learning process, the possibilities are enormous. For example by using everyday objects with RFID tags on them we could have attractive persuasive objects for helping the process of learning.

Some projects have been done for helping the process of learning using RFID, one of them " Merlin's Magic Castle (MMC)" [11] from Elliott and Czeskis students in Purdue University but that has been presented in the form of a larger team (Czeskis, Harvey Chong, and Trisler, all computer science majors; Elliott, genetics; Partick Daly, electrical and computer engineering; Eric Su, computer engineering; Sui Cheng Wong, electrical engineering; and Jasmine Hall), that got a great idea using RFID technology to teach English to non-English-speaking children. Their Merlin's Magic Castle (MMC) [11] software uses RFID tags technology that they embedded in toys. As the project leader Czeskis[12] said:

> *"Merlin's Magic Castle runs on a computer and uses Radio Frequency Identification (RFID) technology that the students embedded in toys. When a toy is run over the computer's scanner, the program registers that RFID, and as Merlin says the toy's name, it also appears on the screen. "These multiple levels of stimulation (audio, video, and haptic [touch]) influence better comprehension and information retention," [13]*

Based on this we have the start point for creating interactive educational objects where the boarder between the tactile and the media is broken.

2. RELATED WORK (STATE OF THE ART)

There are a lot of prototypes in the area of physical computing, persuasive objects in ambient persuasion and intelligence. For this thesis we will only mention a few of them, the most important and related to this thesis.

2.1 AMBIENT ORB[14]

The Ambient Orb [14] is a well-known, commercial example of a smart object particularly suited for office use. It consists of a frosted-glass ball that glows different colors to display real time stock market trends, traffic congestion, pollen forecasts, or any other information channel from a series of available ones like weather or wind speed.

Figure 6 - Ambient Orb

2.2 EYE

Eye: is a student project by David Chawei Hsu and Li-lu Chen, who observed that people working for an extended amount of time in an enclosed space, people (such as office workers) often have the need to find momentary relieves by opening windows to see, hear or reconnect with the outside spaces. EyE is an interactive installation that combines a real window frame, a digital display, and other outputs to create relaxing or surprising window-opening experiences to these office workers as if they are just a

window away from these scenic places. This is an interesting way of providing stress relief at the office, although more evaluation is needed to obtain more clear conclusions.

2.3 THE MEDIACUP[15]

Since office breaks often include time for coffee, we believe the MediaCup [11] should also be listed in this brief related work section. The MediaCup is an ordinary coffee cup augmented with sensing, processing and communication capabilities (which are integrated in the cup's bottom). The goal is to collect and communicate general context information in a given environment.

Figure 7 - MediaCup

2.4 ELE-PHIDGET[16]

Notifications and alerts are also part of a typical office experience. Ele-Phidget, an interactive elephant, is an example of an ambient notification system for an audio chat program. When the user receives a message, the elephant turns around and faces the user. If the user pushes the elephant's stomach the user will listen to the message. When there isn't any messages, the elephant turns away. To record a message, the user squeezes the elephant's head and speaks into the elephant's trunk. A second squeeze stops recording and sends the message.

Figure 8 - Ele-Phidget

2.5 SECOND MESSENGER

There is evidence that ambient displays can effectively persuade users to change their behaviors. DiMicco[17] describes an ambient visualization system called Second Messenger, which groups can use as a method for reflecting upon their own social interaction, as a means to gain a better understanding of it. Second Messenger also provides an automated method for gathering basic information about group interaction dynamics in office and work places. Experimental results indicated that the display influenced the amount an individual participates in a discussion and the process of information sharing used during a decision-making task. It is a very interesting study of the power ambient displays have in a collaborative work setting.

2.6 YSHELVES[18]

yShelves detect shoppers and incorporate vibration, sound and light to attract their attention. As customers stroll along the shopping aisle they are surprised by the sound of a jingle playing, glass bottles vibrating or a fancy lightshow that draws them to a particular product. This is an interesting example of ambient persuasion.

Figure 9 – yshelves

2.7 JABBERSTAMP[19]

Jabberstamp allows children to synthesize their drawings and voices. To use Jabberstamp, children create drawings, collages or paintings on normal paper. They press a special rubber stamp onto the page to record sounds into their drawings. When children touch the marks of the stamp with a small trumpet, they can hear the sounds playback, retelling the stories they have created.

Figure 10 – Jabberstamp

2.8 LOVEM[20]

LoveM is a Technology Sketch of an augmented box of chocolates that displays personal memories on an LCD screen as chocolates are removed from the box. It attempts to evoke joy and surprise through the use of available, inexpensive technology embedded into a familiar object. It investigates what happens when we put technology

in a non-utilitarian, non-game context and explores the ideas of introducing personal, intimate content into an otherwise mass-produced product.

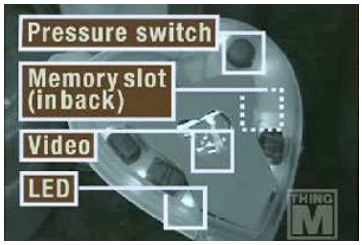

Figure 11 – LoveM

2.9 I/O BRUSH[21]

I/O Brush is a new drawing tool to explore colors, textures, and movements found in everyday materials by "picking up" and drawing with them. I/O Brush looks like a regular physical paintbrush but has a small video camera with lights and touch sensors embedded inside. Outside of the drawing canvas, the brush can pick up color, texture, and movement of a brushed surface. On the canvas, artists can draw with the special "ink" they just picked up from their immediate environment.

Figure 12 - I/O brush

2.10 THE LUMITOUCH SYSTEM[22]

The lumitouch system consists of a pair of interactive picture frames. When one user touches her picture frame, the other picture frame lights up. This touch is translated to light over an Internet connection.

Figure 13 – LumiTouch

2.11 THE GENIEBOTTLES[23]

The geniebottles system presents a story that is told by three genies that live in glass bottles. When a bottle is opened, the genie contained inside is released and begins to talk to the user. If several genies are released at once, they converse with each other. The physical bottles can be seen as graspable "containers" and "controls" for the digital story information.

Figure 14 – GenieBottles

2.12 THE HUG SHIRT[24]

The Hug Shirt is a shirt that makes people send hugs over distance. Embedded in the shirt there are sensors that feel the strength of the touch, the skin warmth and the heartbeat rate of the sender and actuators that recreate the sensation of touch, warmth and emotion of the hug to the shirt of the distant loved one.

Figure 15 - Hug T-shirt

2.13 THE YOU'RE IN CONTROL[25]

The system uses computation to enhance the act of urination. Sensors in the back of a urinal detect the position of impact of a stream of urine, enabling the user to play interactive games on a screen mounted above the urinal. This is a pretty example of one persuasive object for fun.

Figure 16 - You're in control

2.14 MERLIN'S MAGIC CASTLE (MMC) [11]

Merlin's Magic Castle (MMC) [11] is a physical/toy to teach English to non-English-speaking children. It uses RFID technology embedded in toys and when we put a specific toy in the top of the RFID reader, the software in the computer says the name of that toy and writes down the name without one of the letters and asks the children to guess it.

Figure 17 - Merlin's Magic Castle

3. PROJECT PROTOTYPES

The design examples presented in this section are aimed to improve the work-at-the-office experience and stress relief (Wow!Flowers), to act as an alternative way for educational activities(Wow!ABC), for ambient displays of information (Wow!CUBE and Wow!Light), for improving the quality of life with some fun(Wow!TShirt) and by finding a new way of expressing ourselves online, this is sending emotions in a virtual mode (Wow!TouchMe) although all of them could be used in other settings.

We want to create interactive/persuasive objects to improve the quality of life in a new/innovating way.

The main purpose is not to create sound theories, but rather to have proof-of-concept installations and objects, which can then serve as the basis for experiences studying the influence of this kind of persuasive objects on the users' experience.

3.1 WOW!TOUCHME – A COMMUNITY OF SOCIALLY ATTENTIVE USERS

In his book "The Pursuit of Attention: Power and Ego in Everyday Life"[26], Derber explains how the human pursuit for attention is well alive, particularly in America's competitive society. As the review for this book states, "Enough about me, let's talk about you: what do you think of me?" there are many techniques individuals use to turn the course of a conversation towards themselves. Another example of this is the "ego-surfing" phenomenon: surfing the Internet to find occurrences of our own name. Humans, as we know, like to feel they are part of a society, a community.

Another phenomenon that had such impact in Portugal, a few years ago was the use of mobiles phones to transmit emotions by simply dialing a friend's number and hanging up after the first "bip". This was a way of people saying that they care about their

friends, so the basic idea of Wow!TouchMe is this, to send emotions in a new way, in this case over the internet.

Haptic communication is communicating by touch. Haptic interfaces communicate with a computer through a tactile method involving a device that senses touch. Touch is often intimate and can be used as an act of domination or friendship, depending on the context and it in general tends to increase trust. One example of this is the study "The MIDAS Touch"[27] by April H. Crusco and Christopher G. Wetzel where they analyzed the effects of touch and where they had a nice observation that says that waiters who briefly touch their customers receive higher tips than those who do not.

In another article, the article "Virtual Interpersonal Touch: Expressing and Recognizing Emotions Through Haptic Devices"[28] from Jeremy N. Bailenson, Nick Yee, Scott Brave, Dan Merget, and David Koslow, they examined the phenomenon of Virtual Interpersonal Touch (VIT), this is, people touching one another via force-feedback haptic devices and they said that :

> *"if social interaction mediated by virtual reality and other digital communication systems is to be successful, it will be necessary to allow for a full range of emotional expressions via a number of communication channels." [28]*
>
> *"In virtual reality, voice expression of emotion is easy through digitized audio streams. Facial expression is more challenging but certainly possible given recent advances in the computer vision tracking algorithms previously discussed. However, person-to-person haptic interaction, both because of the difficulty of constructing large force-feedback devices as well as the dearth of research in psychology on touching behavior (compared to other nonverbal behavior—see Argyle,1988, for a review), has received less attention than face and voice." [28]*
>
> *"very little is known about the psychological effects of haptic communication, although some research has begun to explore this issue. Basdogan, Ho, Slater, and Shrinivasan (1998) ran a series of studies in which participants used haptic devices to perform a collaborative task and could feel the digital avatars of one another while performing the task. Their results demonstrated that adding VIT to a visual interaction improved performance on a spatial task and increased subjective ratings of "togetherness"" [28]*

So this was the base idea of Wow!TouchMe, to create a persuasive object and at the same time a haptic device for increasing social connectedness and togetherness online by simply creating an object that we could touch to achieve this.

The first prototype was an affective picture frame and the final was in the form of a pig cuddly toy (plush like the teddy bears).

3.1.1 WOW!TOUCHME – SOFTWARE

To connect “Wow!TouchMe” over the internet several solutions came up and at the beginning a flash server plus a nice web flash interface was the more reliable solution. So searching the internet for a free multiuser flash server (since Flash Media Server was very expensive) SmartFoxServer [29] looked like the right solution in part because the open source flash servers at that time weren´t reliable due to the amount of bugs and capacity to handle a enormous number of clients at the same time.

The first approach of “Wow!TouchMe” was done in Adobe’s Flash and SmartFoxServer.

The connection between the two “Wow!TouchMe” objects over the Internet was accomplished through a free Flash server, the Smartfoxserver, which is a server for multiuser Flash applications. The inputs from the “Wow!TouchMe” were translated into messages and sent over the internet. The flash application besides being used for the sounds and music transmitted by the “Wow!TouchMe”, it also acted as a messenger-like program where we could select the user(s) witch we would sent a “touch” over the internet. This solution was abandon due to the fact the free version of SmartFoxServer had a limit of 20 users at a same time.

Figure 18 - A screenshot of the TouchMe! Community, client user interface in flash/smartfox

In December, all the work was lost due to a fatal crash in our laptop (which lead to a 'format c:' as unique solution) and since the backups were obsolete, a reflection time was needed to decide what to do in that situation.

After some days reflecting and analyzing the previous work, the SmartFoxServer solution was abandon and Red5[30] seemed like a good solution to the problems of Wow!TouchMe, it was a really open source flash server, it had support for windows, mac and unix systems, it was reliable, and had support for streaming audio and video in real time, we could attach a camera to the affective picture frame and stream video, audio and the emotional touch's.

With Red5 we could have a cheaper and more reliable application/server to support the "Wow!TouchMe" object so a flash application was developed to interpret the inputs from the phidgets interface kit that was inside the "Wow!TouchMe" object. It had all functionalities implemented, stream audio with the heart sensor, sending a touch by the change of an input in the "Wow!TouchMe" object, a chat with public and private sections, a list of friends to who the touch would be sent.

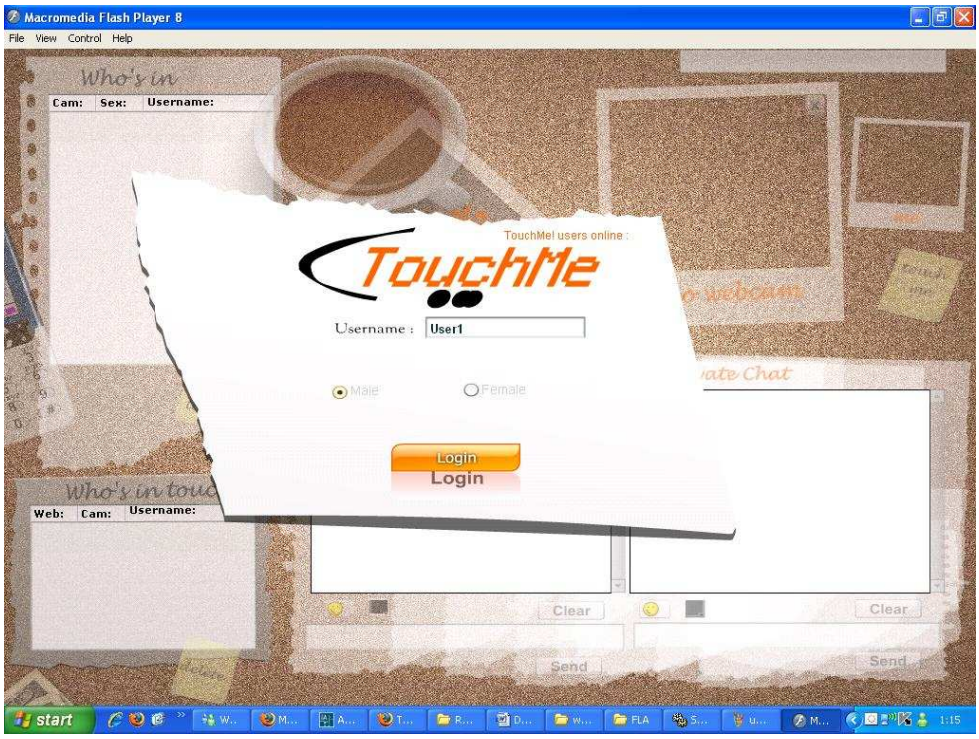

Figure 19 - Wow!TouchMe login screen in flash/red5

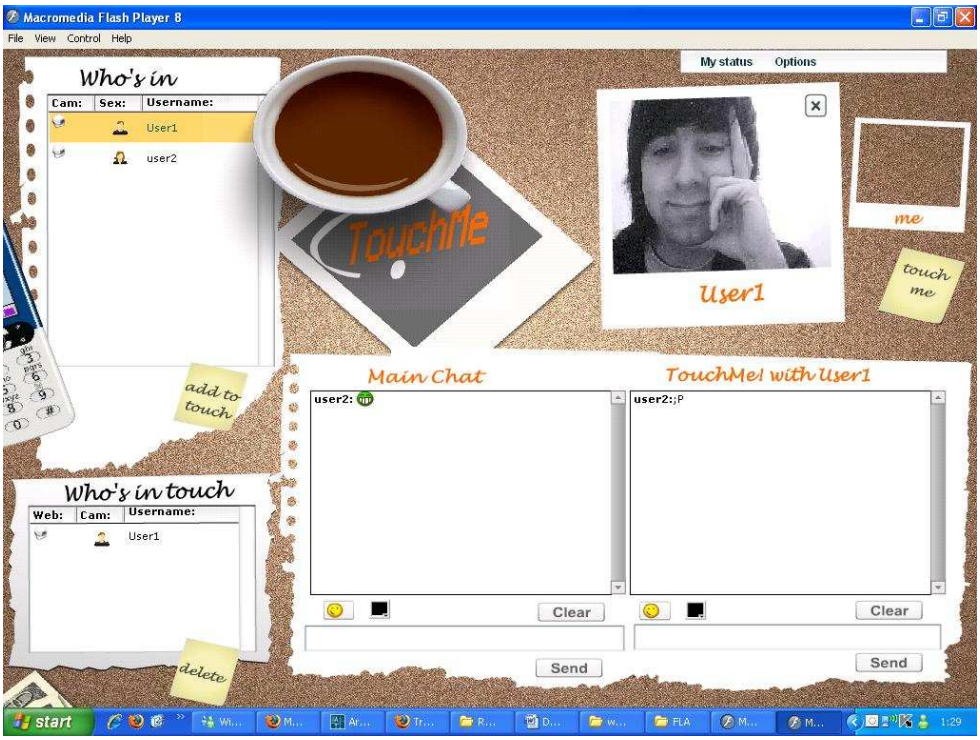

Figure 20 - Wow!TouchMe main screen in flash/red5

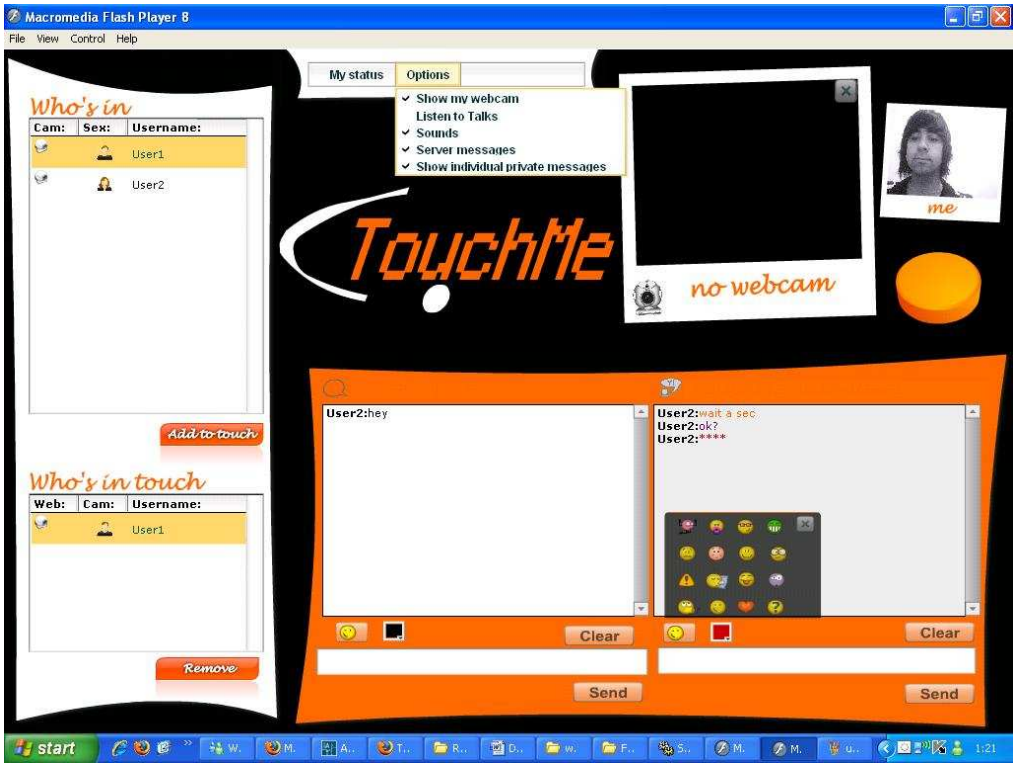

Figure 21 - Wow!TouchMe different layout in flash/red5

Then some questions come up in our heads, 'how to test it?', 'would people go to a website with a chat to send emotions over the internet?', 'wouldn't it be nicer if the was connected to something that they use every day and so we decided after having one more application finished that we could do better, we were in a learning process, and learning by the hard way, doing the prototypes and getting outputs and getting the feeling that we could do something better, something not being notice by the user directly, we had to eliminate the flash interface in a website and at the same time give the user an option to select real friends in real life to transmit emotions without adding more applications that the ones they already used everyday.

The solution was all the time in our front, when we asked opinions to our friends online, when we communicated online everyday, it was the MSN Messenger [31]. After some research to see if it was possible or not, a MSN API for C# came across, it was finally the solution we had been months searching for, it was free, the server side was secure, we had already a list of friends, no complex setups or files to be installed. And as *'comScore Networks'*[32] revealed in a study:

> *"The MSN Messenger application has the strongest penetration worldwide, with 61 percent of worldwide IM users utilizing the application in February. MSN Messenger is also dominant in Latin America, reaching more than 90 percent of IM users, and in Europe and Asia Pacific, reaching more than 70 percent of IM users in each region. North America is the most competitive IM market, with MSN Messenger, AOL/Aim and Yahoo! Messenger each garnering between 27 percent and 37 percent of IM users in February."[33]*

It was perfect, nobody would notice they were "running" a persuasive object, the integration of the "Wow!TouchMe" object with their favorite IM application would look magical but there was a small issue to fix, the C# application had to be executed from an .exe file every time the MSN Messenger was lunched so in practice we would have two programs, the MSN Messenger and our little C# to interface from the "Wow!TouchMe" object to the MSN Messenger.

After researching for a solution that would really be stress relief and not otherwise, we found it, we would have to develop a script in JavaScript for Messenger Plus[34] which is an add-on for MSN Messenger used by more than 47 millions of people. To access the phidgets [4] interface kit a call for an ActiveX object was made to a ".dll" file from the PhidgetsManager (which was something new, in the Phidgets supported languages, JavaScript wasn't there, this took a little while to figured how to call an ActiveX object and handle it (inputs and outputs in the phidgets [4] interface kit). So a script to interact with the messenger was created, the user would simply install it by double clicking on it, then a menu could be access from the messenger program as shown in the next figure (figure 22):

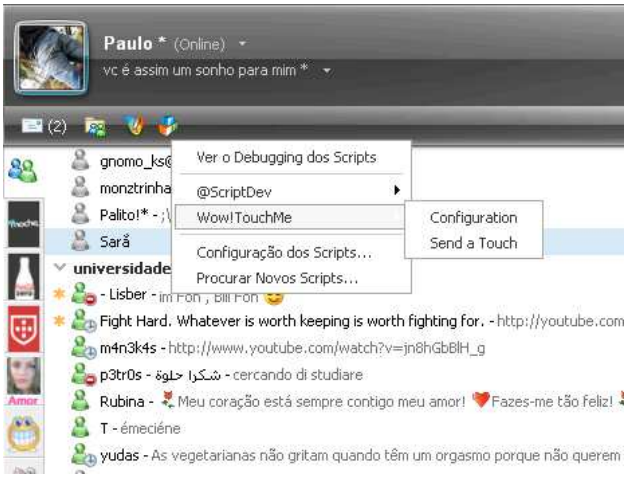

Figure 22 - Wow!TouchMe MSN script

And by clicking in the configuration it will open a pop-up window with 4 tabs, “Info”, “Touch list”, “Options” and “About”.

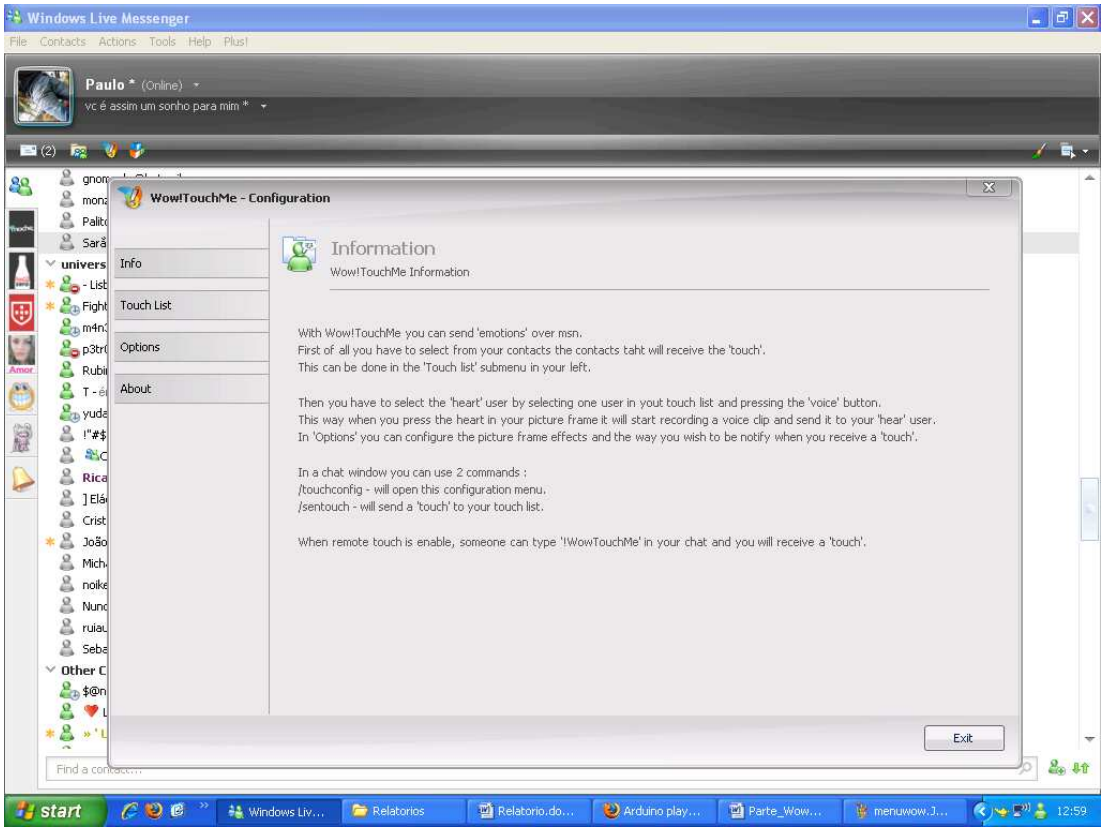

Figure 23 - Wow!TouchMe configuration window

In the “Info” tab it displays the basic information about this script and how does it work, how to send emoticons without a “Wow!TouchMe” object, simply by msn commands.

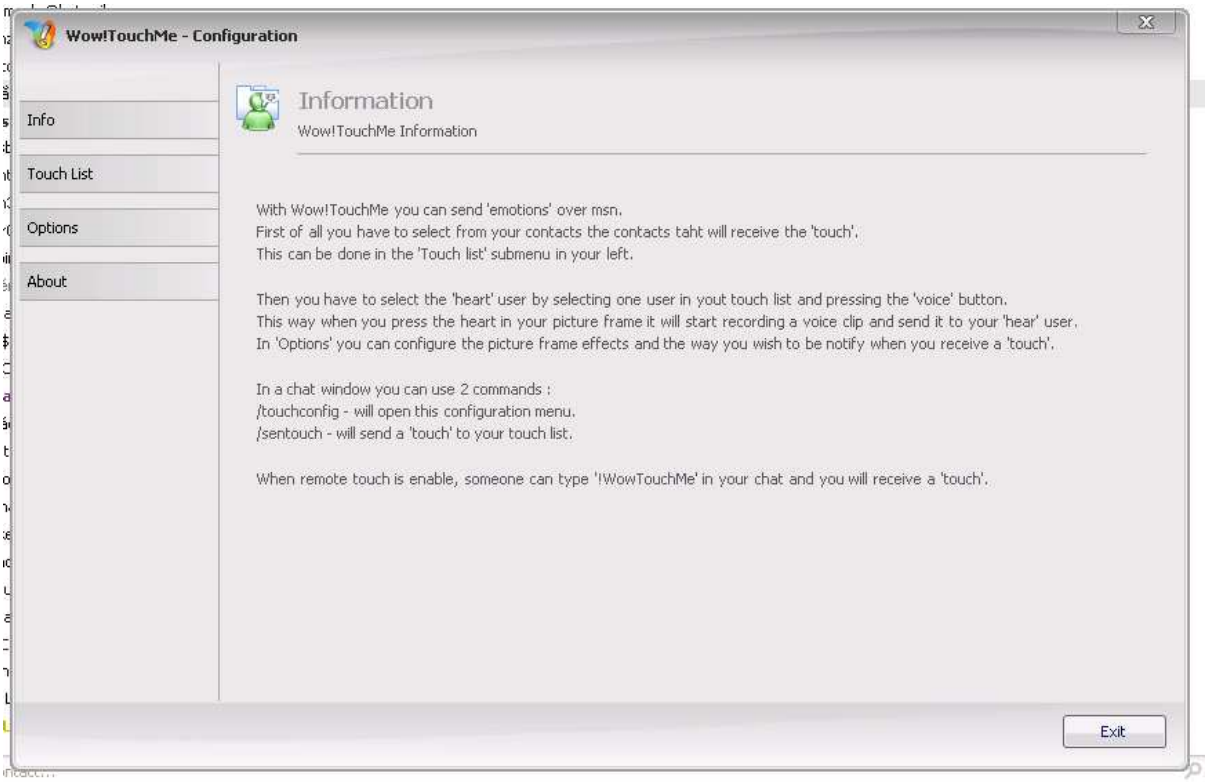

Figure 24 - Wow!TouchMe Information tab

The “Touch list” tab is where we select the user that will be part of our touch list, this is when we press the button to send a touch in our “Wow!TouchMe” object, it will send the touch to the users in the “touch list”. Also here we have to select the user that is the voice/heart user. When we press the heart in our “Wow!TouchMe” object it will open a MSN chat conversation window with that contact and start recording a voice clip to send after we release the heart button, if we press the heart and we don’t have any voice user selected, it will display a msn toast, like when a user signs in, with a message warning us that we don’t have any voice user and if we click in that toast, it will open the configuration window. Also a warning is displayed if the user is offline.

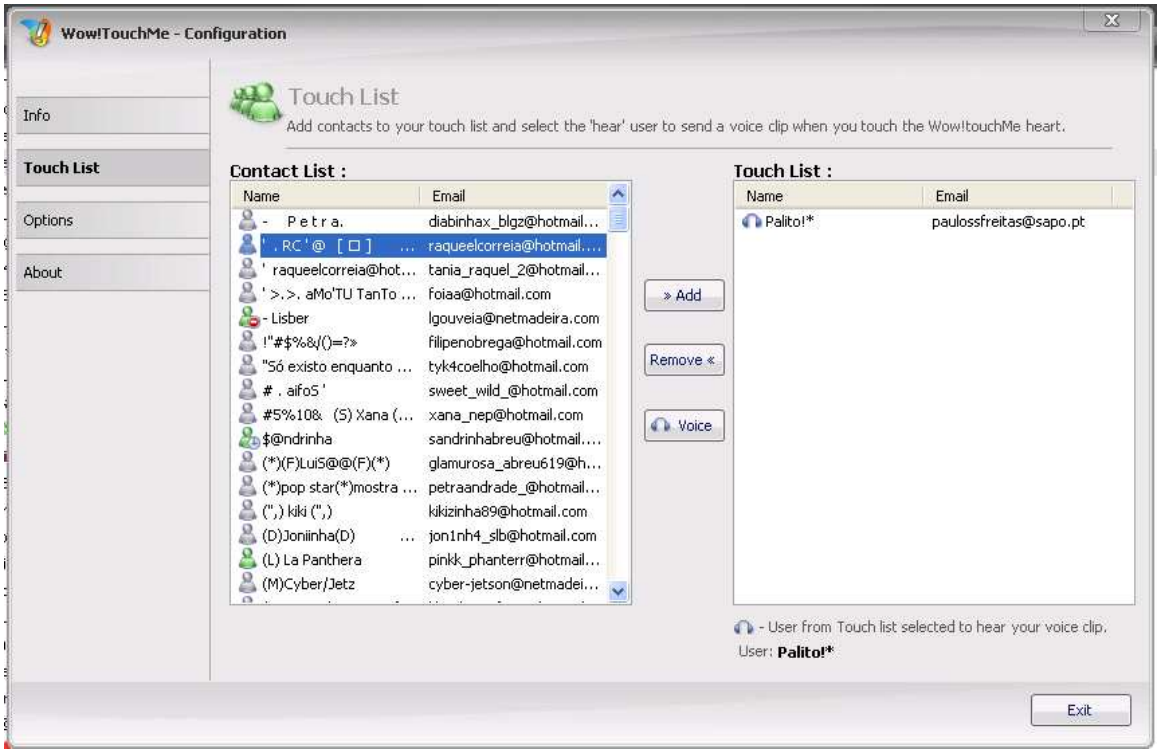

Figure 25 - Wow!TouchMe Touch list tab

In the “Options” tab we can select if we want to receive a touch (sound, notification toast and effect on the pig plush) when we’re busy or not in MSN; if we want to be notified by a MSN toast when we receive a touch; if we want to interpret a heart emoticon in MSN “(L)” as a touch, this is, if someone sends us the emoticon of the msn heart the script will recognize it as a touch; if we want to receive remote touchs by the text “!WowTouchMe”, this is when someone that doesn´t have the script or persuasion object WowTouchMe wants to send us a touch, they can simply write “!WowTouchMe” in our/their MSN chat window; if we want do hear a voice saying “you have received a touch” every time we receive a touch; if we want that a character appears in our screen saying that we have receive a touch, saying hello and good bye when we sign in and out (if running in windows vista the character will also talk the text instead of only showing it in the screen), warning us if we try to do something wrong and finally we can chose the effect to be displayed in our “Wow!TouchMe” object when we receive a touch.

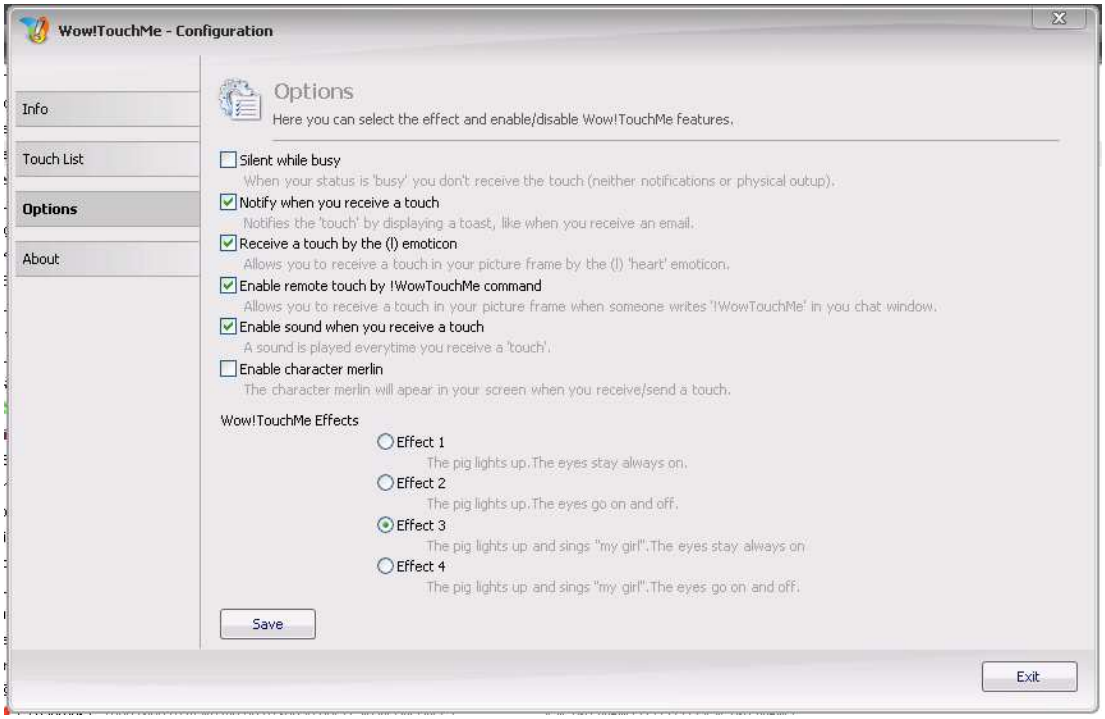

Figure 26 - Wow!TouchMe options tab

The tab “About” is simply a basic information about the script.

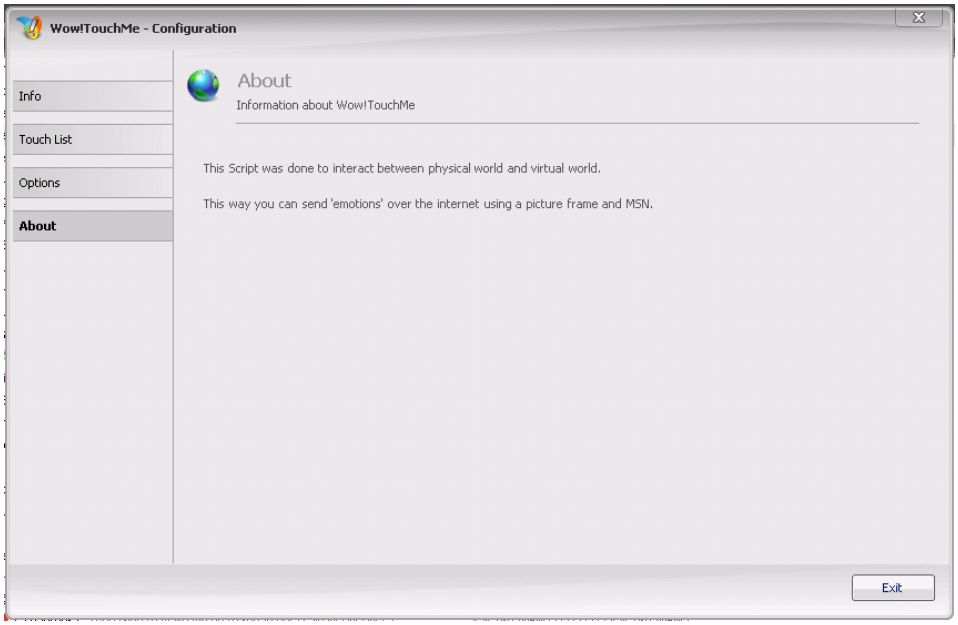

Figure 27 - Wow!TouchMe About tab

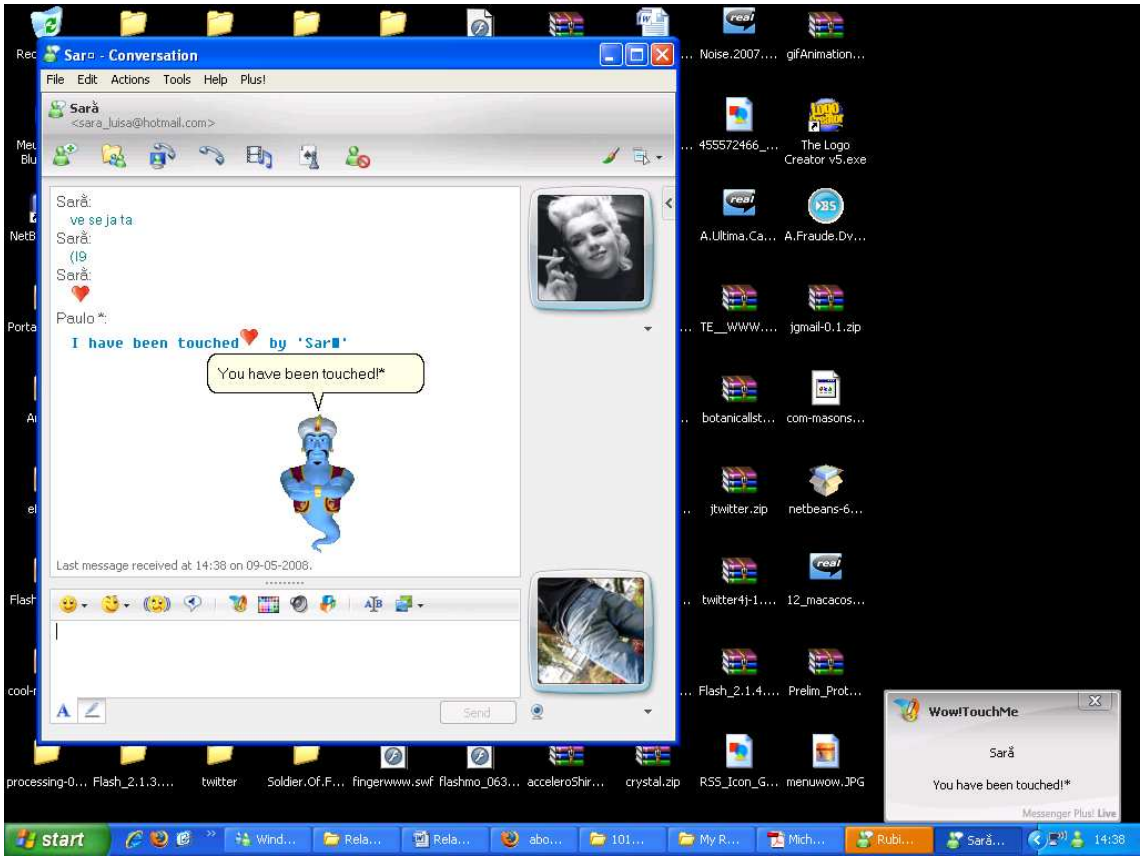

Figure 28 - Wow!toucheMe simple example of a touch being received.

3.1.2 WOW!TOUCHME FIRST PROTOTYPE - AN AFFECTIVE FRAME

"Wow!TouchMe" as an affective picture frame. The basic idea was to have two affective picture frames connected to different computers and transmit "emotions" over the internet. Each affective picture frame had sensors and LEDs embedded, as illustrated in the figure bellow. When the user touches the sensor in his/her affective picture frame, the system would send a message over the internet to the other affective picture frame that lights up the LEDs in that picture frame. This was the first prototype and was similar to Lumitouch, except for the sensors which were more flexible in "Wow!TouchMe", and the online community of "touchers" which we could send emotions not for only one person but for an entire community/group of friends. We incorporated with the affective picture frame a sensing heart. The sensing heart was similar to the switch in the affective picture frame, but instead of sending a "touch" it would start recording the user's voice and would send it over the internet to the users in

our touch list. This object was designed in order to take advantage of relaxing muscle tension from time to time, which can contribute to relieve the stress, while at the same time maintain a connection with other remote user.

The affective picture frame hardware consists of a Phidgets [4] InterfaceKit 8/8/8, some LEDs as outputs (the prototype had six of them) and two basic switch (on/off). The affective picture frame was done in wood and connected to the PC via USB.

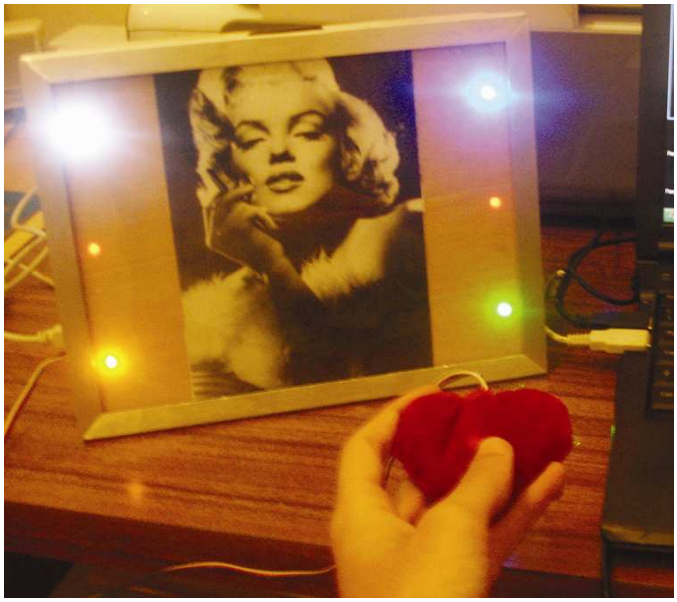

Figure 29 - Illustration of the Affective Frame with the Sensing Heart

3.1.3 WOW!TOUCHME FINAL PROTOTYPE - PIG CUDDLY TOY (PLUSH)

We decided to make a new prototype because after some simple questions to some persons of what they would like to have around the PC, an everyday object that would help them transmitting emoticons and they said that the picture frame was a little bit “insensitive” and they could not used it when they were in the sofa or in bed with their laptops.

So a pig cuddly toy (plush) seemed to be the right choice, everyone had a cuddly toy (plush) /teddy bear when they were kids and in most cases it transmits a feeling of calmness and happiness.

The pig cuddly toy (plush) could act like as a new friend, it would always be around us. We would have to take care about it, connecting and disconnecting via USB, "feeling"/touching it to send touch to our friends and hear the pig plush sing for us and get his eyes blue when someone sends us a touch. In our minds it would be a perfect persuasive object for sending emotions over the internet.

The pig cuddly toy (plush) hardware is basically one phidgets [4] interface kit 8/8/8, optocouplers for controlling the singing part, two blue LEDs (as we can see in the ambient smart flowers, the blue light has a calmness, relief stress effect), one white LED in the pig nose, one sensing heart in his chest(the same used in the affective picture frame), one basic switch is his left leg and another small pieces of hardware to make the cuddly toy (plush) pig sing.

Figure 30 - Wow!TouchMe pig plush connect to the computer with his nose light up

Figure 31 - Wow!TouchMe pig plush with his eyes on

3.1.4 WOW!TOUCHME - WHAT IS NEEDED TO RUN IT?

To run Wow!TouchMe we only need :

- The Wow!TouchMe object, in this case the cuddly toy (plush) pig and connect it over the USB port.

- Install the Phidgets21Manager from the url www.phidgets.com -> downloads or from the Wow!TouchMe folder (This also needs Microsoft .NET 2.0 and the installer is also in the Wow!TouchMe folder).

- Have MSN Messenger and MSN Plus installed (MSN Plus is included in the Wow!TouchMe folder).

- Install the Wow!TouchMe script file “Wow!TouchMe.plsc” by double clicking on it (included in the Wow!TouchMe folder).

-Install the genie Microsoft agent by double clicking in “genie.exe” (also included in the Wow!TouchMe folder).

- Configure the Wow!TouchMe options in MSN.

3.1.5 WOW!TOUCHME - CONCLUSIONS

To test our prototype we have created a simple questionnaire and gave it to the testers. We have tested the Wow!TouchMe pig plush object with eight different persons and all of them liked the idea of receiving/transmitting emotions over the internet.

The install process and the usability of the object were simple and good to all of them and they considered that the pig plush was a good choice.

More tests are needed to conclude something for real, if this could be a way to transmit emotions in a near future but we believe with the few data we have collected that this could increase the quality of life.

This prototype was also shown to 3 kids around five years old and they liked it very much, especially the outputs (LEDs and ping singing) that for them looked magical because it was controlled over another PC and not the one the cuddly toy (plush) pig was connected to.

The Wow!TouchMe has been tested over Windows XP and Windows VISTA operating systems and it worked very well in both cases.

3.2 AMBIENT SMART FLOWERS (WOW!FLOWERS)

The role of nature in calming humans is well recognized. To exploit how this role could be used in persuading the office worker to feel better, we developed the ambient smart flowers.

A recent research about flowers and the “important role they may have in our daily lives conducted” [35] by Nancy Etcoff [36], Ph.D., of Massachusetts General Hospital and Harvard Medical School, reveals that spending some time with fresh flowers can affect our feelings and mood. This study revealed that flowers could increase energy,

happiness and enthusiasm at work and make people feel less negative. And as Etcoff [36] , said:

> *"As a psychologist, I'm particularly intrigued to find that people who live with flowers report fewer episodes of anxiety and depressed feelings," Etcoff [36] , says. "Our results suggest that flowers have a positive impact on our well being." [35]*

so based on this study, the flowers were the perfect ambient device to persuading office workers to feel better, we wanted to achieve the same result in the office as the flowers have in people's home, making people feel in home at the office.

After researching about flowers we discovered that the "most beautiful flowers, in conjunction with their design and color schemes, create feelings that enhance our mood. They are a simple and sincere way to lift our spirits. " [37] so we decided to make some pretty flowers, not just one flower in a vase, our prototype had feedback from two florists ("Florista Margarida" store in Madeira) that gave us some advices about artificial flowers.

With the first prototype finished, we decided that we could add some more elements for reducing stress, based on stress relief techniques as aromatherapy and color therapy.

Aromatherapy is the practice of using naturally extracted aromatic essences from plants for physical and emotional health and well being, these aromas have been used for many centuries by various cultures such as Chinese, Egyptians, Greek, Persian and others for their medicinal and mood altering properties and they have direct effects on human behavior and physiology. The Lavender (Lavandula) plant is well known for the sedative, antispasmodic, and tranquilizing effect, so we decided to add the lavender aroma to our ambient smart flowers (Wow!Flowers) because based on several studies it has been proved that this aroma (lavender) successfully relieves stress. Some of these studies are bellow:

- ***"Ethnopharmacological evaluation of the anticonvulsant, sedative and antispasmodic activities of Lavandula stoechas L"*** [38] where A. H. Gilani, N. Aziza, M. A. Khana, F. Shaheena, Q. Jabeena, B. S. Siddiquib and J. W. Herzig

tested its possible anticonvulsant and antispasmodic activities in mice and the sedative effect of lavender was confirmed.

> *"The sedative effect of the plant extract was confirmed, as it prolonged the pentobarbital sleeping time in mice similar to that of diazepam." [38]*

- ***"Effectiveness of Aroma on Work Efficiency: Lavender Aroma during Recesses Prevents Deterioration of Work Performance"*** [39] where Reiko Sakamoto, Kazuya Minoura, Akira Usui, Yoshikazu Ishizuka and Shigenobu Kanba investigated if lavender aroma during recess periods affected work performance and using 36 healthy male students in three groups, one with lavender, one with jasmine and one control group they concluded that lavender prevented deterioration of work performance.

> *"Comparison of the three groups for this time period indicated significantly higher concentration levels for the lavender group than for the control group. No such effect was noted for the jasmine group. Although lavender is a sedative-type aroma, use during recess periods after accumulation of fatigue seems to prevent deterioration of performance in subsequent work sessions." [39]*

- ***"AROMATHERAPY,POSITIVELY AFFECTS MOOD,EEG PATTERNS OF ALERTNESS AND MATH COMPUTATIONS"*** [40] where Miguel A. Diego, Nancy Aaron Jones, Tiffany Field, Maria Hernandez-Rief, Saul Schanberg, Cynthia Kuhn, Vvirginia McAdam, Robert Galamaga and Mary Galamaga tested EEG activity (Electroencephalography (EEG) is the measurement of electrical activity produced by the brain), alertness, and mood in 40 persons using aromas. The aromas used were lavender (relaxing odor) and rosemary (stimulating odor) and simple math computations were given before and after the aromatherapy with these aromas. The lavender group revealed less depressed

mood, more relaxed and performed the math computations faster and more accurately.

> *"The present study evaluated the effects of two commonly used odors on anxiety, mood, relaxation, alertness, math computations and EEG activity. Our findings support other research studies showing that certain aromas can positively influence mood (Roberts and Williams, 1992). The Lavender group reporting feeling more relaxed and their increase in beta power supports previous findings on lavender's ability to increase frontal beta power (Lorig et al., 1990), promote leep (van Toller, 1988)." [40]*
>
> *"The math computation results suggest that although both groups performed the computations faster after the aroma session only the lavender group showed improved accuracy on math computations following the sessions. This finding was surprising because the lavender group did not show the enhanced alertness EEG pattern that the rosemary group showed. Perhaps as reflected in both self report and EEG data the lavender group was more relaxed and thus better able to concentrate. This and previous research indicate that aromas can effect psychological and physiological changes" [40]*

Color therapy is based on the belief that every color has its own language and that they can affect our moods and behavior. For example, the blue color has a soothing and calming effect on our nerves. Based on some studies about color and respective emotions we have selected some of them:

- ***"THE REDS, WHITES, AND BLUES OF EMOTION: EXAMINING COLOR HUE EFFECTS ON MOOD TONES"*** [41] where April S. Odom & Shannon S. Sholtz tested the relationship between color and emotion on 60

students and see if different colors had different moods reactions. The results supported that different colors had different moods reactions.

> *"In general, the results of this study support that different colors do invoke different moods. Some mood tones for certain colors are more pronounced than others. Yellow was found to be both cheerful and exciting while blue was associated with being calm." [41]*

- ***"Relationship between color and emotion: a study of college students"*** [42] where Epps, Helen H.; Kaya, Naz college students were asked to indicate their emotional reactions to different colors and they concluded that several colors had different emotions over the students. In the blue case 80% revealed positive reactions.

> *"Blue elicited a high number of positive emotional responses, including the feelings of relaxation and calmness, happiness, comfort, peace, and hope, with a low number of negative responses, including sadness and depression. Reasons that blue elicited positive emotions seem to be because many participants associated the color blue with the ocean, beach, water, or the sky and thus inducing relaxing and calming effect. Blue evoked negative emotions because it was associated with the night and dark skies, thus making someone feel depressed. One respondent said blue made her sad because "it makes you feel blue". Interestingly, Saito (1996), who found that vivid blue was the preferred color among all of the Asian groups, noted only positive aspects related to the color blue, namely refreshing, beautiful, and bright." [42]*

So based on this studies we decided to incorporate a blue light and lavender aroma to our artificial flowers.

In resume, the ambient smart flowers (Wow!Flowers) are aware of when the user is in the office desk and they look bright and happy, spread a calm aroma when the user is sitting at the desk. When the user leaves, the flowers lean towards the floor, looking sad. This is a different idea that could be promising in improving the office experience, without being too much of a distraction.

3.2.1 AMBIENT SMART FLOWERS (WOW!FLOWERS) HARDWARE & SOFTWARE

The artificial flowers hardware is basically a microcontroller board based on the ATmega168; a servo motor that makes the flowers (three of them) wilt or bloom (when it detects someone); a presence sensor (IR sensor) disguised into the flowers that checks if the user is sitting at his/her desk working, or if he/she is leaving the office; a fan that will spread the lavender aroma when someone is detected in front of the flowers and a blue LED that will bright while the flowers are bloomed with a special effect, it will look like the light is getting sleepy to produce a calm sensation to the user.

The physical part took some weeks to figure out how to make the flowers bloom and wilt in an efficient way, it could have a more impressive look if we had a stronger servo motor, perhaps in the future it could be done but the idea is the same, only not so impressive with our servo motor.

The flowers were coded in Arduino[3] language that is based on C/C++. The main problem was how to transform the IR sensor input in reliable data because the IR sensor input is voltage so we had to transform it into a usable distance measurement so after innumerable tests we decided to apply an existing formula based in the one from Acroname Robotics [43] for the IR sensor.

Figure 32 - Wow!Flowers fan detail with lavender aroma inside the green cube

Figure 33 - Wow!Flowers bloom

Figure 34 - Wow!Flowers wilt

3.2.2 AMBIENT SMART FLOWERS (WOW!FLOWERS)- WHAT IS NEEDED TO RUN IT?

To run the ambient smart flowers (Wow!Flowers) we only need to connect the flowers with Arduino 6V 1.5A Power supply to the power. Because ambient smart flowers (Wow!Flowers) have the code in the microcontroller we don't need to connect them to a PC.

3.2.3 AMBIENT SMART FLOWERS (WOW!FLOWERS) – CONCLUSIONS

The ambient smart flowers (Wow!Flowers) have been up for more than one month continually without powering them off to test if they were robust and if the microcontroller, the electronics parts and specially the IR sensor servo motor could perform their job without being affected by time and inconstant values. This proves that the ambient smart flowers (Wow!Flowers) could be powered on and then let them always on letting they do their stress relief job without the need to being always turning them on and off when we go to the room where they are in.

During this time, it has also been tested by us in our home and we can say that it was a nice effect when arriving at the computer and the flowers bloom and wilt when we leave. We didn't get any stressed and looking at the flowers and smelling the aroma that they spread away it transmitted a calm effect. Of course we can not conclude that these flowers are 100% stress relief, we would need more tests and perhaps some tests with electromagnetic brain sensors to conclude something more scientifically but we believe that these Wow!Flowers or it's idea someday in the future will become more and more common in our everyday objects.

Everyday objects will become smart and will help us improving our life quality.

3.3 WOW!CUBE

Everyday we need information from the internet and sometimes we need that information in real time. It can stressful when we're always checking our e-mail for a new e-mail or for other information on the internet.

We decided to create a wireless cube with a LCD that would display all that kind of information because with this cube, we could be waiting for an e-mail in front of the TV and when it arrives, it would be displayed in the cube that is wireless so we could place it around the office/home.

Several software prototypes for the Wow!CUBE were created, because we have developed a simple protocol to communicate between the Wow!CUBE and the java software. The same Wow!CUBE can display a variety of information depending of the java software running, we can display the unread e-mail, RSS feeds and so many thing we can think of.

The data that we can display in the Wow!CUBE is every data we can think off, local or remote data.

The idea was to create something with a simple protocol that could turn future development easier and without any hardware modification.

The microcontroller part is done in Arduino language that is based in C/C# and it finds a way to be always available to connect to the java software and receive/send data to it, when it doesn't receive information for a specific time period from the software it will come back to the stage where it is accepting new connections and clears the display and shows "Wow!CUBE" in the display.

The first prototype of Wow!CUBE was made of a metal box with a basic on/off switch. The Wow!CUBE final prototype was made of wood and to turn it more friendly and attach emotions to it, the on/off switch its like a girl's head that when we place the head over the Wow!CUBE it turns on, and when we remove the head it turns the Wow!CUBE off. This was the way to turn it more friendly and to make people see it as a little fellow that would help them displaying useful information and therefore help

them reducing stress/improving quality of life by not being always online seeking for that information.

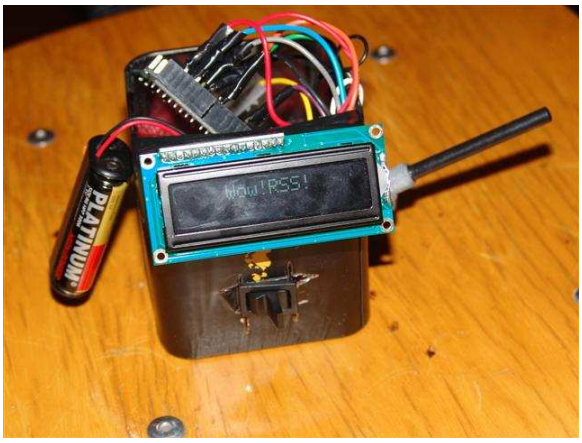

Figure 35 - Wow!CUBE first prototype

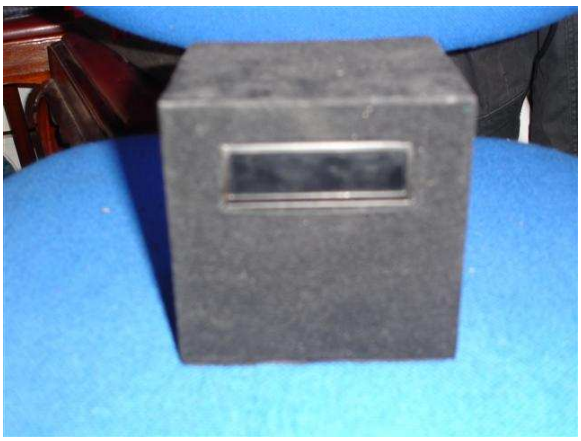

Figure 36 - Wow!CUBE final prototype turned OFF

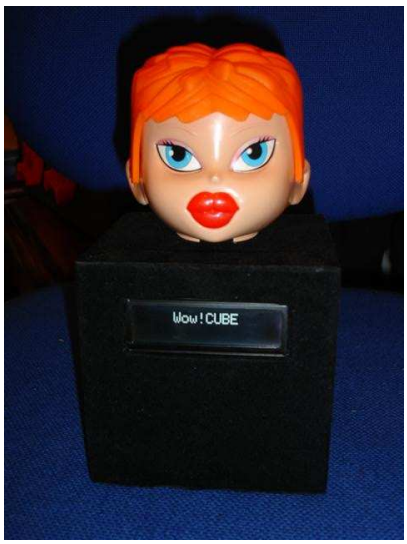

Figure 37 - Wow!CUBE final prototype turned ON (with the girl head in the top of the cube)

3.3.1 WOW!CUBE - HARDWARE

The Wow!CUBE hardware is basically a microcontroller board based on the ATmega168 with Bluetooth (BlueGiga WT11), a blue LED (as we can see in the ambient smart flowers, the blue light has a calmness, relief stress effect), one potentiometer to control the LCD brightness, a power supply support for 3 AA batteries, a LCD that will display the information and a magnetic switch to turn the cube on and off. To get the LCD working some weeks were spend because we had to solder it all up and discover how to connect it, which pins to solder and connect to the microcontroller (and modify the exiting LCD library to adapt to our needs and available output) and then how to write characters to it and make them scroll.

Figure 38 - Wow!CUBE inside viewed from backside

3.3.2 WOW!CUBE – RSS READER SOFTWARE

Wow!CUBE RSS reader software was written in the form of a java applet in Processing and it consists in a RSS feed reader that communicates with the Wow!CUBE via Bluetooth serial port and sends the feeds to the LCD display in the Wow!CUBE.

When executing the Wow!CUBE software, which can run in windows/mac/unix systems, we have a blue interface where we can select the right Bluetooth serial port to our Wow!CUBE and then a text box where we can write down the RSS feed link or we can simply drag the URL (feed link) to the software interface and it will recognize it and

show it in the text box. When it finishes sending all available RSS feeds to the Wow!CUBE it reads again the RSS URL to get updated RSS feeds and starts sending them all over to the Wow!CUBE and does always this cycle.

It has other features as zero installation (just double-click to run), no traces left behind (does not generate logs), small (only 2 Mb) and operating system independent.

This software is robust because we check if it's an RSS URL, if it's online, if we have internet connection before and during the execution of the software, what serial ports exists in the current computer and if they are available or not. Because the LCD in the Wow!CUBE does not recognize some characters as "ç", "é", "ã" for example, we exchange them for "c", "e", "a" respectively.

The software is a little bit slow when it starts because the only available/reliable serial port library for java is slow itself and also because of the fact that we wanted to check and give only available serial ports to the user to choose and not a lot of them.

Figure 39 - Wow!CUBE RSS example from www.abola.pt feed

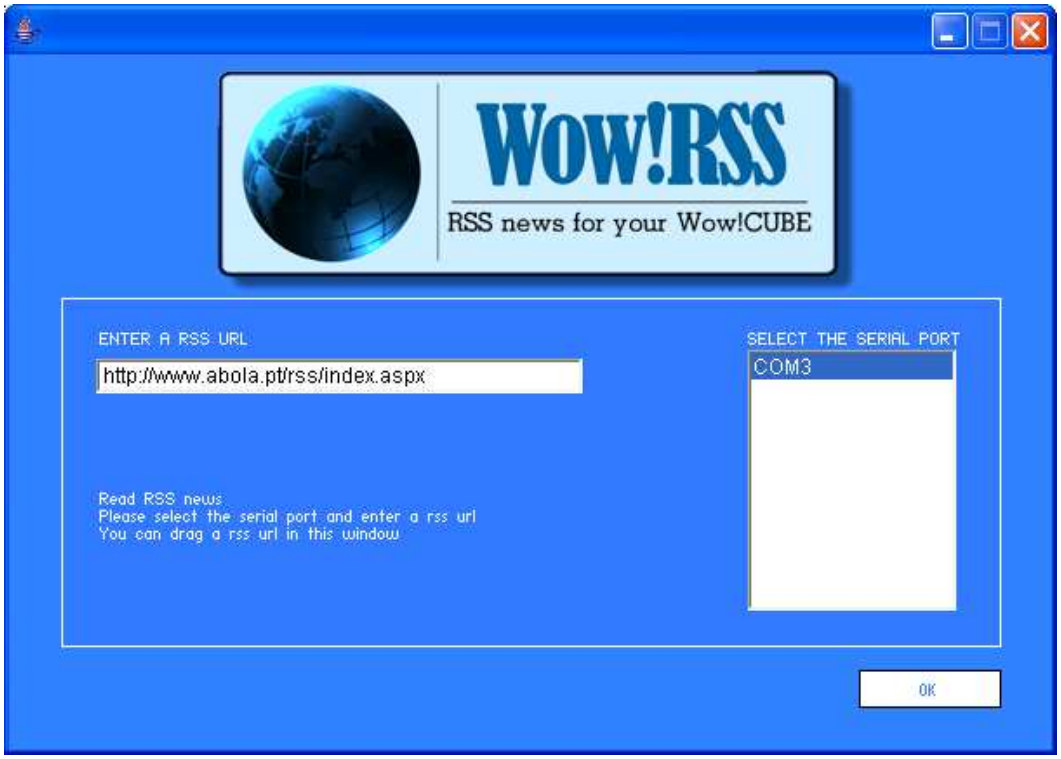

Figure 40 - Wow!CUBE RSS reader software initial screen

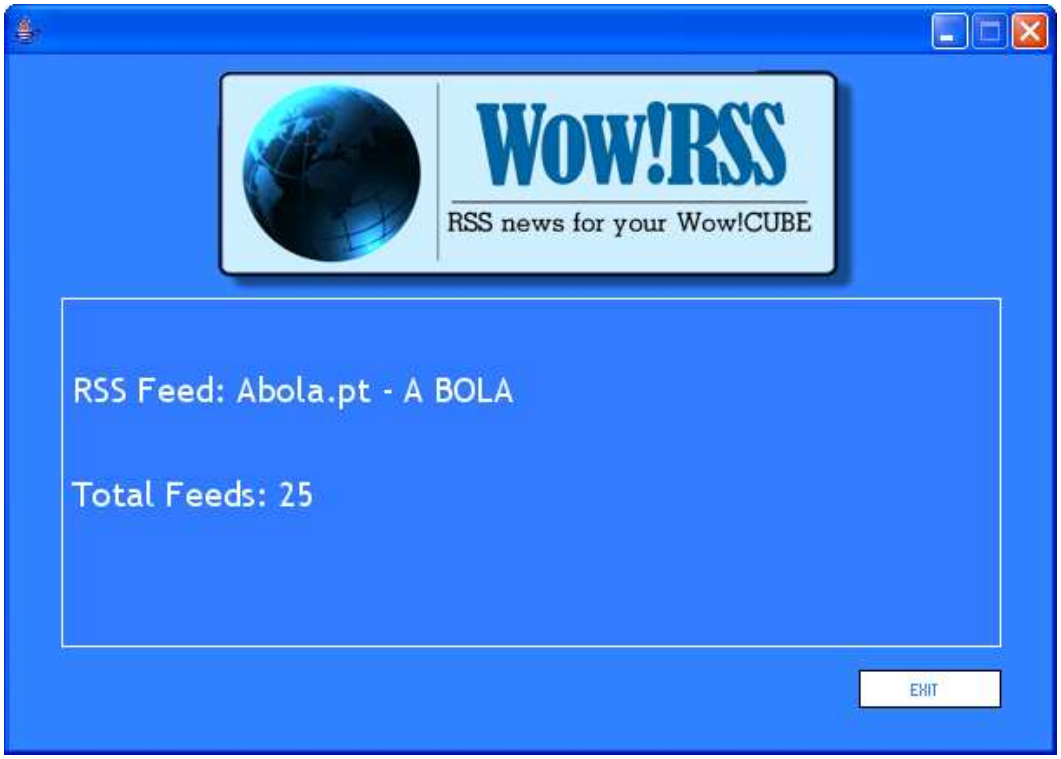

Figure 41 - Wow!CUBE RSS reader software final screen

3.3.3 WOW!CUBE – GMAIL NOTIFIER OF UNREAD MAIL SOFTWARE

Wow!CUBE Gmail notifier of unread mail software was written in the form of a java applet in Processing and it communicates with the Wow!CUBE via Bluetooth serial port and sends the data from unread mails in the “Inbox” folder to be displayed in the Wow!CUBE.

When executing the Wow!CUBE software, which can run in windows/mac/unix systems, we have a blue interface where we can select the right Bluetooth serial port to our Wow!CUBE and two texts boxes for Gmail username and password. Here we can select if we will be using Wow!CUBE or Wow!Light to display the information.

The software accesses our Gmail accounts securely using IMAP over SSL. The software checks the Gmail account every 80 seconds for updates.

It has other features as zero installation (just double-click to run), no traces left behind (it does not generate logs), small (only 1 Mb) and operating system independent.

The unread Gmail mails are displayed in the LCD, in the form of “unread mail #1: from:xxx@xxx.com subject: hey you”. Because the LCD in the Wow!CUBE does not recognize some characters as “ç”, ”é”, “ã” for example, we exchange them for “c”, “e”, “a” respectively.

This software is robust because we check if we have internet connection, if the username and password are right and also checks internet connection during execution, what serial ports exists in the current computer and if they are available or not.

The software is a little bit slow when it starts because the only available/reliable serial port library for java is slow itself and also because of the fact that we wanted to check and give only available serial ports to the user to choose and not a lot of them.

Figure 42 -Wow!Gmail software settings screen

Figure 43 - Wow!Gmail software final screen

3.3.4 WOW!CUBE - WHAT IS NEEDED TO RUN IT?

To run Wow!CUBE we need :

- The Wow!CUBE object.

- Place the girl's head in the top of the Wow!CUBE to turn it on (power it on).

- We have to pair the Wow!CUBE with the computer and create a virtual serial port for it. Look for a Bluetooth device called **BTCUBE** and the pass code is **12345.**

- Run the java software and select the Bluetooth serial port on it.

-To switch it off simply turn the head sideways or take it off from the top of the Wow!CUBE.

3.3.5 WOW!CUBE - CONCLUSIONS

Wow!CUBE has been designed to be an attractive object that could display information in a new way. We think that objects like this could improve the quality of life in the point that we don't need to be always searching for information updates in the computer because it is displayed in the Wow!CUBE.

In our software we have RSS feeds and notification of unread Gmail mails as an example of what we can display in the Wow!CUBE and we can display everything we could think of, from online data to computer process level of activity.

It's nice to have an object like this but we will need to make some studies to see if this could really improve quality of life and what information/data (to be shown in the Wow!CUBE) was best to achieve that.

3.4 WOW!LIGHT

The persuasive object Wow!Light is similar to the persuasive object Wow!CUBE but instead of outputting the information in a text form (in a LCD), it analyses that information and displays it as a color.

The Wow!Light has five colors, white when it is simply turned on (acting like a desktop lamp) and four color for displaying information, red, blue, orange and green. This persuasive object is also wireless, what means we can place it all around the office/home. Like the Wow!CUBE it also acts as a information display in the point that it could display useful information in different colors making it a nice persuasive object.

The same way we developed a simple protocol between the Wow!CUBE and java, we used a similar one to communicate between the Wow!Light and java software.

The microcontroller code is coded in Arduino language that is based in C/C# and it finds a way to be always available to connect to the java software and receive/send data to it, when it doesn't receive information for a specific time period from the software it will come back to the stage where it is accepting new connections and the light turns white again.

The software prototypes developed for Wow!Light were only a small example of what can be done with this persuasive object, basically we can display any online and offline information in the Wow!Light.

The Wow!Light first prototype was made of wood and glass and the final with some kind of metal and acrylic.

To make it a different object, several ways to power and turn it on were thought and we choose an original one, that makes use of a mercury tilt switch and so to turn it on, we have to put the Wow!Light upside and when we want to turn it off we simply turn it downside (rotate the Wow!Light 180º degrees). This way we wanted to make use of the notion of "inverse", by turning the Wow!Light on, we inverted it and in our minds we ideally would associate this to something positive, like "wow, there's light" , turning something black in something white.

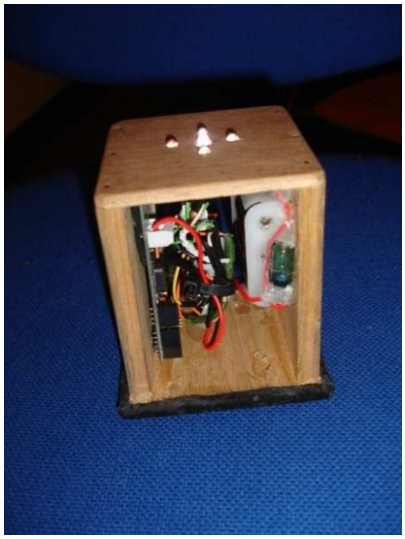

Figure 44 - Inside of Wow!Light first prototype

Figure 45 - Inside of Wow!Light final prototype

Figure 46 - Wow!Light final prototype turned ON with blue light notification

Figure 47 - Wow!Light final prototype turned OFF

3.4.1 WOW!LIGHT - HARDWARE

The Wow!Light hardware is basically a microcontroller board based on the ATmega168 with Bluetooth (BlueGiga WT11), 5 LEDs (white, blue, green, orange and red), power supply support for 3 AA batteries, a mercury tilt switch and some resistors for the LEDs.

3.4.2 WOW! LIGHT – WEATHER DISPLAY SOFTWARE

Wow!Light weather display software was written in the form of a java applet in Processing and it communicates with the Wow!Light object via Bluetooth serial port and sends the weather data from the internet to the Wow!Light object to be shown as a color.

When executing the Wow!Light software, which can run in windows/mac/unix systems, we have a blue interface where we can select the right Bluetooth serial port to our Wow!Light, a list of Portuguese cities in which we can select one to display weather information of it and radio buttons to chose between humidity or ultraviolet light index

in the city that we have selected. Then the data is converted to a five color scale and the right color is show in the Wow!Light. This data is being always updated, after the data is sent to the Wow!Light, the java software updates the data from the internet and sends it back to the Wow!Light, it's a cycle.

It has other features as zero installation (just double-click to run), no traces left behind (does not generate logs), small (only 1 Mb) and operating system independent.

This software is robust because we check if we have internet connection before and during execution and what serial ports exist in the current computer and if they are available or not.

The software is a little bit slow when it starts because the only available/reliable serial port library for java is slow itself and also because of the fact that we wanted to check and give only available serial ports to the user to choose and not a lot of them.

Figure 48 - Wow!Weather software initial screen

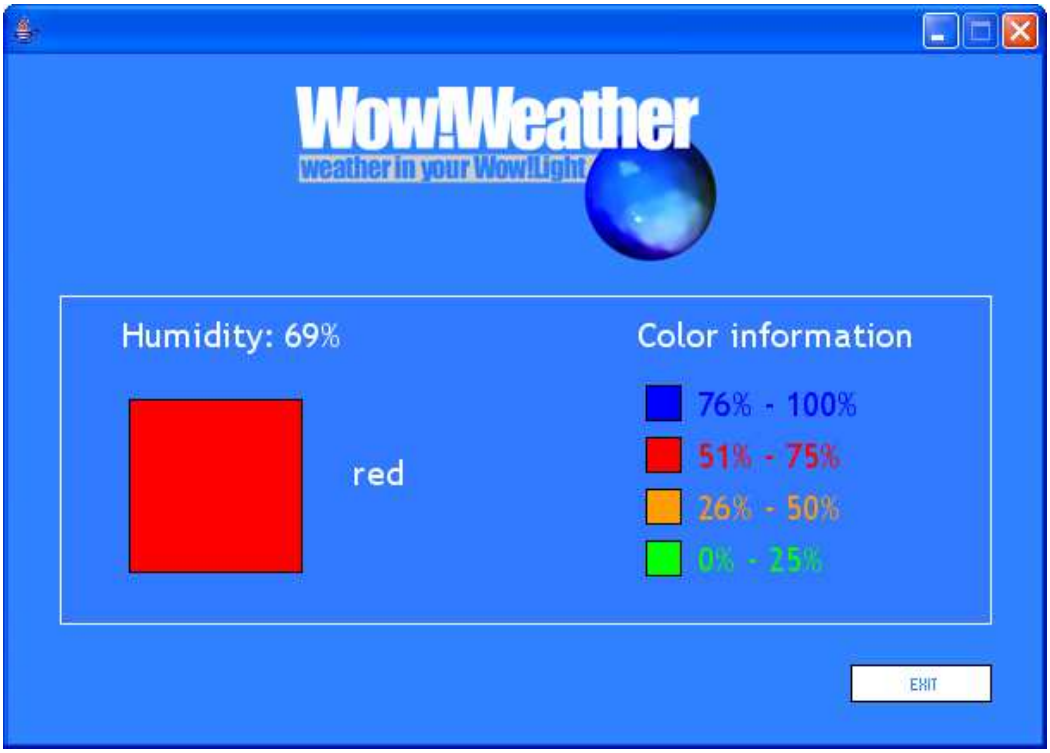

Figure 49 - Wow!Weather humidity screen

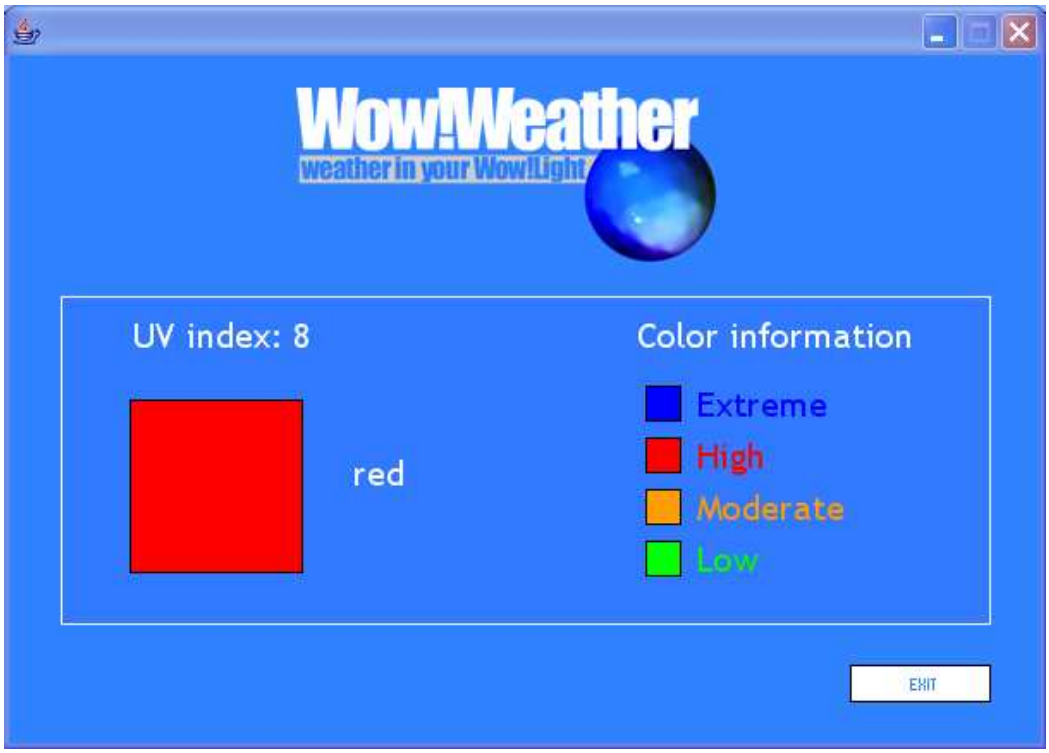

Figure 50 - Wow!Weather UV index screen

3.4.3 WOW! LIGHT– GMAIL NOTIFIER OF UNREAD MAIL SOFTWARE

Wow!Light Gmail notifier of unread mail software is the same software of Wow!CUBE Gmail notifier of unread mail where we can choose the hardware between Wow!CUBE and Wow!Light, and when we have unread mail the Wow!Light will turn green otherwise white. This was done to show that we can have the same software for a different hardware and turn our applications more robust and general to a set of "wow!objects".

3.4.4 WOW! LIGHT – SIMPLE TIMER NOTIFIER SOFTWARE

Wow!Light simple timer notifier software was written in the form of a java applet in Processing and it communicates with the Wow!Light via Bluetooth serial port and notifies from a timer in the Wow!Light turning it green and blue.

When executing the Wow!Light software, which can run in windows/mac/unix systems, we have a blue interface where we can select the right Bluetooth serial port to our Wow!Light, and we can choose the hour and minutes to the alarm (these values are set to the current time, this is, if current time is 16:22 the hour is set to 16 in the hour combo box and the minutes to 22 in the minutes combo box). If the alarm date is set to a time that has already past the alarm is set to the next day at that time.

When the time of the alarm is reached, the Wow!Light will turn green and then blue sequentially. This software is robust because it checks a lot of exceptions and what serial ports exists in the current computer and if they are available or not.

It has other features as zero installation (just double-click to run), no traces left behind (it does not generate logs), small (only 1 Mb) and operating system independent.

The software is a little bit slow when it starts because the only available/reliable serial port library for java is slow itself and also because of the fact that we wanted to check and give only available serial ports to the user to choose and not a lot of them.

Figure 51 - Wow!Timer initial screen

Figure 52 - Wow!Timer final screen

3.4.5 WOW!LIGHT - WHAT IS NEEDED TO RUN IT?

To get the prototype Wow!Light running we need:

- The Wow!Light object.

- Turn the Wow!Light upside to get it ON.

- We have to pair the Wow!Light with the computer and create a virtual serial port for it. Look for Bluetooth device called **WowLight** and the pass code is **12345.**

- Run the java program and select the Bluetooth serial port on it.

-To switch it OFF simply turn the Wow!Light downside.

3.4.6 WOW!LIGHT - CONCLUSIONS

Wow!Light can be a useful object to display information in the form of different colors LEDs. With this we can create an enjoyable, comfortable and nice ambient around us.

Some studies are needed to see if this object can improve our quality of life and which colors are best to show information. We didn't have time to make these studies, only simple tests with us and some friends and we have noticed that it was a cool object that can give us information whiteout perturbing us with noises or annoying messages in the computer.

One problem with this prototype was the hardware part, how to make a power and visible light source because we had just one LED of each color, we had to use white acrylic plastic but the result was not very visible at sun light, only inside a room we could see the different colors. This was an issue that we could improve in the future, perhaps using another acrylic, the transparent or some sort of white transparent glass (we had used one in a first prototype but it was very fragile and was always breaking out), we could also use four LEDs of each color, making this way a stronger visible

light but we only had one LED of each color available for this prototype. The general idea of this object is visible and we know that with some further work (not programming work but handmade works) we could have a nice and powerful light object.

3.5 WOW!ABC

We know that as much as teaching provides such a feeling of fulfillment, it can also be a draining career, mentally, emotionally and physically.

This can lead to a stress situation, so we want to make a persuasive object to help the process of teaching and at the same time make this object something that the kids can play and learn with. It would be great for both parts, reducing stress in teachers by the new process of learning where kids would learn the basics by themselves. The kids would be learning and they would think they were just playing with some nice object that has a feedback on the computer screen, helping them in the process of learning in a non stressful way.

Multimedia learning is more and more common in our days and has the power of being more appellative for children and as described in the “Introduction” of this thesis we have seen from several studies that multimedia learning can help the process of learning so we wanted to take advantage of that in our Wow!ABC persuasive object.

So we want to create a multimedia learning application for the Portuguese alphabet but somehow the interface should be a persuasive object because this application is for first grade students or below and they don’t know how to use a computer.

Multimedia learning applications are child-friendly but the keyboard and mouse interface aren't.
So we want to develop a new interface more child-friendly, like a cuddly toy (plush) and some RFID cards that they could put near the cuddly toy (plush) and change the alphabet letter on the computer screen.

Some may say that we could simply use the computer mouse as the interactive part of our application but as we can see children have small hands and they don't know how to hold the mouse and some computer mice have a lot of buttons, making it harder to the small children from first grade that only have around six years old.

3.5.1 WOW!ABC - HARDWARE

The Wow!ABC hardware is basically a phidgets [4] RFID which is place inside a cuddly toy (plush), some LEDs and some RFID cards for each letter of the alphabet. The RFID tag cards were design to be appellative to the kids.

Figure 53 - Wow!ABC RFID cards for each letter

We have done two versions of the Wow!ABC cuddly toy (plush).

The first version of the Wow!ABC RFID reader was totally homemade, it was a cuddly toy (plush) in the form of a cute little pink monster and two blue LEDs were added as eyes and the interface kit board was put inside it.

Figure 54 - Wow!ABC first prototype "pink monster"

The second version of the Wow!ABC RFID reader was done with a cute teddy bear with two blue LEDs, two white LEDs and an interface kit board inside his chest.

Figure 55 - Wow!ABC second prototype "teddy bear"

3.5.2 WOW!ABC - SOFTWARE

The multimedia Wow!ABC application is a learning tool to help children from first grade and lower to learn the Portuguese alphabet.

Since it was for kids around six years old, the data had to be based on images, audio and animations so we choose Macromedia Flash 8 (now it belongs to Adobe) to code it because Flash could give us a nice tool to make it more attractive and “cool” for the kids.

The multimedia Wow!ABC application is in the form of a book, like the books that kids have in their schools and home, but this one is virtual, a virtual book with all the letters from the alphabet.

Each letter takes two pages (right and left page, like page 2-3, 6-7) and in the left one we have an image showing how to draw that letter (capital and lower case) with arrows and numbers and in the bottom the name of something that starts with that letter. In the right page we have the image of something that starts with that letter for a better visualization of that letter, an animation of a girl with a board showing how to draw that letter in (capital and lower) and a sound with a voice of a girl spelling that letter and the name of something that starts with that letter, for example in English the sound would be something like this “letter b, letter b for banana”.

To interact with this multimedia application we need the Wow!ABC object and when we put a different letter card in front of the Wow!ABC object it changes the page in the virtual book for the page of the letter in the card.

The main problem developing this application was to find the appropriate images for each letter, finding a way to attach sound to it and making it robust so it would not crash since six years old kids doesn’t have a linear way of using it.

Another version of Wow!ABC was created to be used with the computer mouse and not with the Wow!ABC cuddly toy(plush). This version was basically to support teachers, to older students with some difficulties in the alphabet and also a way that all kids could have an interactive multimedia book without having the money to buy the Wow!ABC cuddly toy(plush).

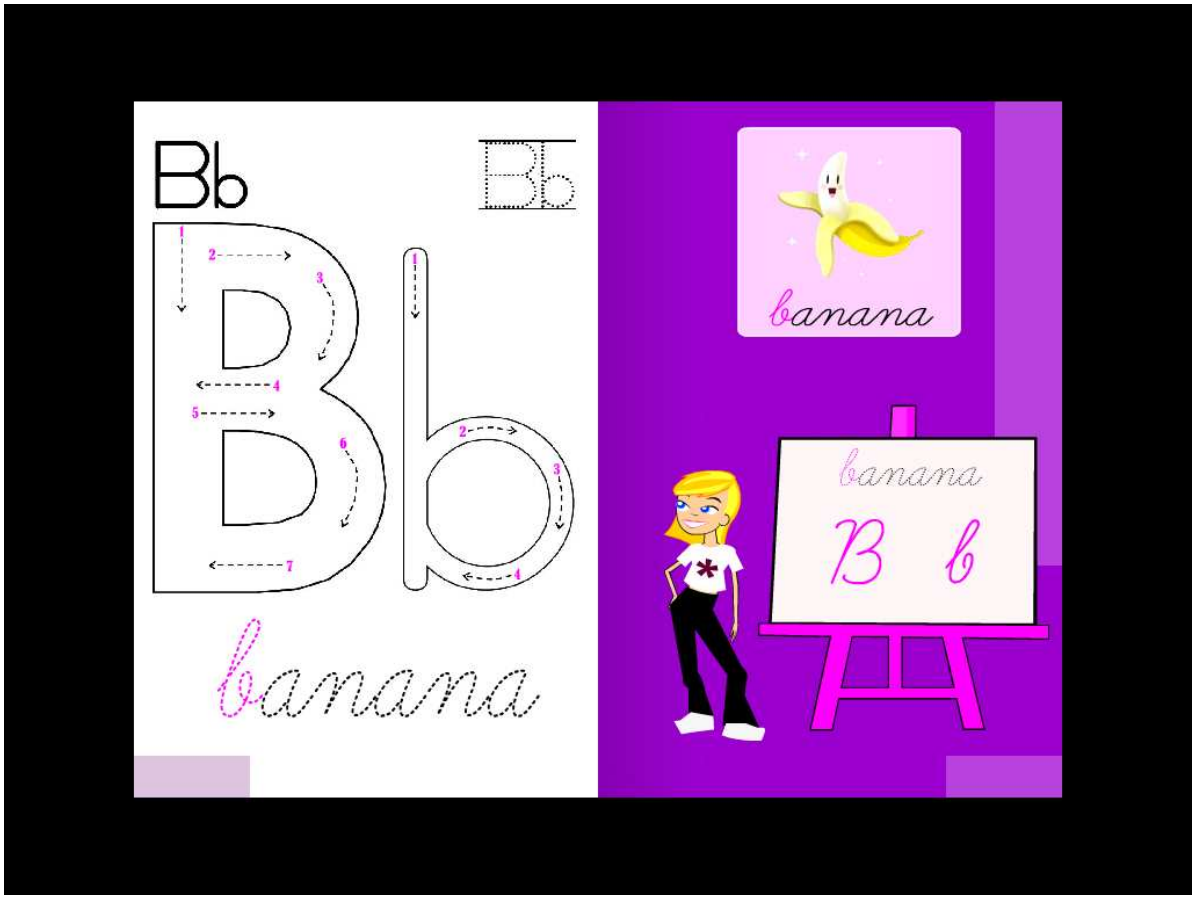

Figure 56 - Wow!ABC interactive book

3.5.3 WOW!ABC - WHAT IS NEEDED TO RUN IT?

To run the Wow!ABC we need :

- The Wow!ABC cuddly toy (plush) object and RFID cards for each letter.

- Install the Phidgets20Manager from the url www.phidgets.com -> downloads or from the package Wow!ABC that contains all necessary files to install an run this application (This also needs Microsoft .NET 2.0 and the installer is also in the Wow!ABC folder).

- Have flash player 8 at least.

- Run the abcflashV1.0Phidgets.exe file or abcflashV1.0Phidgets.swf for other operating systems (from the Wow!ABC folder).

-Use one card at a time and pass it near the Wow!ABC cuddly toy (plush) to change the alphabet letter.

- To use the mouse version, run abcflashV1.0NoPhidgets.exe file or abcflashV1.0NoPhidgets.swf for other operating systems (from the Wow!ABC folder).

3.5.4 WOW!ABC - CONCLUSIONS

This prototype has been tested with 3 kids, a girl with six years old and a boy and a girl with four years old.

The girl with six years old is in the first grade and she's learning the alphabet letters at school, when she played with Wow!ABC she said that it was really nice, the physical object and the cards, she saw it was a game. After playing a while, she could tell almost every image associated to each letter and recognize all letters in the cards by saying what letter it was in the card design.

The two kids with four years old when first looked at the cards didn't recognize any letter but after playing a little with it, they found Wow!ABC very cool, and they couldn't stop putting cards in front the belly of the teddy bear. After they have finished playing with it (what took a while) they could recognize almost half of the images associated with each letter and pronounce the sound of that letters.

With this simple test, we saw that Wow!ABC could in fact help kids in the process of learning. Of course we can not conclude that this is a scientific fact, a rule, for that we would have to make more exhaustive tests, go to schools and make some (a lot of) studies with real students from different grades.

All the 3 kids found the Wow!ABC object very cool, they liked the lights in the object and the fact that they could control an application in the computer just with a teddy bear and some nice cards without using the mouse or keyboard.

When doing the same tests but with the mouse instead of the Wow!ABC object they played a little with it but the mouse interaction was a little bit difficult to them so they stopped playing with it.

3.6 WOW!TSHIRT

Nowadays we all want smart clothes or fun clothes, so we decided to make this prototype in the wearables area, the Wow!TShirt.

Wow!TShirt is an interactive t-shirt where people can have a feedback when touching us, basically when someone touches us in the hand printed in the t-shirt a noise is emitted and then a RGB LEDs lights up with a random color from red, blue, orange our green and the person can see the result in the t-shirt, for example if the red led lights up, the person has won a kiss from the person wearing the t-shirt.

This is a simple idea that can be used to make people interact with us increasing our quality of life.

The Wow!TShirt can also be used in other environments like in marketing and publicity to make people interact with beautiful ladies wearing this kind of t-shirt and touching them to win merchandising of a specific product.

Figure 57 - Wow!TShirt prototype

Figure 58 - Wow!TShirt main hardware inside the t-shirt pocket

Figure 59 - Inside of Wow!TShirt

Figure 60 - Wow!TShirt OFF

Figure 61 - Wow!Tshirt when someone touches the hand

3.6.1 WOW!TSHIRT – HARDWARE AND SOFTWARE

Wow!Tshirt hardware is basically a microcontroller (Arduino [3] Lilypad), a power supply support for one AAA battery, a RGB LED, a buzzer, some conductive threat, a washable homemade switch and silicone to protect the conductive threat.

It was a little bit difficult to make the washable homemade switch and to connect everything with the conductive threat since it was not so good conductive and several other issues that we had to handle with when creating this prototype.

The software was coded in Arduino language that is based in C/C# and uploaded to the microcontroller.

3.6.2 WOW!TSHIRT - WHAT IS NEEDED TO RUN IT?

To run Wow!TShirt we just have to put the AAA battery in the power supply support and turn it on.

Then wait that someone touches in the hand designed in the t-shirt.

3.6.3 WOW!TSHIRT - CONCLUSIONS

Wearing the Wow!TShirt for an entire day was definitely fun, several persons approach us to touch the t-shirt and have their “prize”.

It would be definitely fun wearing the Wow!TShirt in a disco to see the effect, other places should also be tested so we could have more information and conclude something but from what several people said and during the time we wear it, it was a success.

Perhaps the idea of interactive clothes is something that makes people feel more in community and have an excuse to approach other persons and therefore feeling themselves happier.

The hardware part was not so simple to work out; we have burn out one power supply during the process of uploading code and also the homemade switch wasn’t 100% reliable because the conductive threat was always unweaving. Another issue with the conductive threat was its resistance, 14 Ohms per foot so we had to put all the circuit parts near each other to eliminate high resistances.

4. CONCLUSIONS AND FUTURE WORK

This thesis focuses on several purposes and goals for creating persuasive objects prototypes. All the prototypes described in this thesis are flexible enough to be used in a variety of places/situations.

Based on the recent informal evaluation of each of the examples described, there are many opportunities for innovation through the use of persuasive interactive objects.

The hardware development of these objects can look easy but it took a lot of time, to learn how to connect some electronic parts, how to get them working with the microcontroller, to discover formulas to transform the input voltage in reliable information, to solder up everything since we had separate parts and we had to join a lot of them. So, a considerable time was spent in this area what made us learn a lot more than just programming, we believe this is what make us engineers, to know how to work and learn a little bit of everything so we can innovate, improve and be prepared to face the future in computer engineering.

In order to obtain feedback from worldwide specialists in this field of research, we submitted a paper about this work to a CHI'2008 workshop titled "Surrounded by Ambient Intelligence". The paper was accepted with very positive reviews. Some of the items discussed at this workshop were:

- Theoretical foundations of Ambient Persuasion
- Frameworks and heuristics for the design of persuasive AmI applications
- User experience in persuasive ambient environments
- Application areas for ambient persuasive technologies
- Case studies and examples of ambient persuasive systems
- Methods and tools for research on Ambient Persuasion
- Ethical and privacy questions regarding Ambient Persuasion

And some of the feedbacks we had by e-mail when they accepted our paper are below:

"Recommendation : Definite accept [5]
Reviewers Expertise: Knowledgeable [3]
Originality of Work: There is a significant increment [4]

Scientific Contribution: With this position paper the authors discuss ambient persuasion within a special context: the working environment. The authors state that there is a huge potential for improving the human work experience by using ambient persuasion technology. They introduce TouchMe, an affective picture frame and The Sensing Heart a tangible, hart shaped prototype through which it is possible to transmit „emotions" over the internet. They state that through these interfaces it is possible to provide workers with a less stressful work experience."

"The authors present some very interesting prototypes which could be used for ambient persuasion purposes in an working environment. Although the conection between their goal to reduce stress situations within the working environment and their prototypes is not clear for me, it would be interesting to discuss their insights they got from designing their prototypes. I would recommend a formal evaluation of their prototypes to get more insight on the persuasive aspect.

"Recommendation : Probably accept [4]
Reviewers Expertise: ()
Originality of Work: The increment is limited [3]

Scientific Contribution: The paper discusses the potential role of ambient information displays for stress reduction in the office envrinment. More specific, the role of an abmient systems in reducing interruptions and creating increased social connectedness are the key elements of this discussion. The authors discuss some applications that could play a role in realising these goals."

During the workshop in which Pedro Campos (our master thesis supervisor and also author of the paper along with us) was on and then shared the information about it, he encountered many researchers interested in the work being developed and many interesting discussions arose. In general, the workshop participants all agreed that there was an urgent need to design, develop and evaluate a new generation of truly useful interactive objects, which could be embedded into everyday life, following Mark

Weiser's vision of ubiquituous computing. However, many goals are still far from being reached. Interesting prototypes were presented, but are outside the scope of this thesis.

Regarding the prototypes we presented, the main issue is related to evaluation. This concern - obtaining reliable methods for evaluating users' reactions to interactive objects - is still a major challenge that must be faced by researchers in this field and every project presented suffered from this aspect. Three very useful suggestions for future evaluations of theses systems were given:

- apply emotional response sensors and measure the user's degree of happiness or stress during a significant period of time;

- use a webcam with facial expressions recognition software to record the users' emotions from their faces and obtain some insight regarding the distress-level of the object;
- employ more conventional and easy methods, such as surveys and questionnaires.

Based on this, we have evaluate our prototypes with simple tests, by watching the users using our prototypes in a silent way so they could not notice that we were evaluating the prototype and with questionnaires and simple oral questions.

Analyzing each conclusion that we have discussed in the “conclusions” part of each persuasive object developed we can say that the basic idea of each one was generally right. However, more research is needed regarding the actual usage of this new generation of objects. A formal, extensive evaluation has to be undertaken in order to discover the hidden aspects of the influence this kind of objects has on the users’ feelings. This is a first step towards building new interactions capable of improving the users’ experiences, work styles and quality of life.

The connection between the several objects goals and the prototypes presented is not very clear because we didn’t had time and the right tools (EEG electromagnetic brain waves for stress relief as example) to test them. So some tests are still necessary to demonstrate the several persuasive objects goals. To achieve this, some user investigation with and without the prototypes is needed and then the differences are analyzed so we can have acceptable conclusions.

Therefore, future work for this thesis should include addressing the evaluation aspect in order to obtain more solid conclusions. Nevertheless, we believe that the informal tests that were undertaken throughout this thesis are a step forward towards achieving really interesting and pleasant interactive objects.

It also should be considered for future work making the prototypes more robust and improve the communication between them so that they can communicate, not only with the computer but also have our software running in mobile phones and other devices that we already have at home/office, making this way real general persuasive object for the future.

Also in future work we have a lot of options to make more and original persuasive objects. During this thesis we have searched and developed other “prototypes” that we didn’t present because we didn’t had time to finish them.

In those prototypes we had a jacket to control an “IPOD” only with some buttons and a microcontroller so we could have the “IPOD” in the jacket’s pocket and control it by some buttons in the jacket sleeve or by an accelerometer instead of the buttons. The part to communicate between the microcontroller and the “IPOD” to send instructions like “play/pause”, “stop”, “next” and “previous” has been all developed/coded, but we didn’t had time to put it in a jacket and also because of the homemade switches that did not work as well as we plan.

Another “prototype” that we had in mind, was to control a microcontroller with a mobile phone, what we had developed so far, was a simple way to had one mobile phone connected to the microcontroller via Bluetooth, and then the mobile via a python script running on it would analyze all incoming SMS and transmit the orders in them to the microcontroller. Here’s a simple example, we had a coffee table with some LEDs on it controlled by a microcontroller and connected to a mobile phone, when we would sent the SMS “TURN GREEN” to a mobile number that would be placed over that table (that number would be the number of the mobile connected to the microcontroller) the table would turn green. This idea would be great to control a lot of things, since sculptures in museums, coffee tables, disco lights, make interactive shop stores, the potential is enormous. We didn’t advance with it because we used the two Bluetooth

microcontrollers to the Wow!CUBE and Wow!LIGHT and also because we didn’t had time to make all the prototypes ideas that we had in our minds.

There’s a lot of thing to do and a new world to discover out there in persuasive objects.

Our only wish was to have more to present all our ideas and cool objects in this thesis.

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APPENDIX

APPENDIX A: AMBIENT PERSUASION FOR RELIEVING THE STRESS AT THE OFFICE PAPER

Ambient Persuasion for Relieving the Stress at the Office

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ABSTRACT

This position paper discusses an alternative application area for ambient persuasion, coined as “work style-improvement persuasion”. Based on previous research on work styles, current research literature on ambient persuasion, and working prototypes under evaluation, we argue that this is a promising application area that should be handled by effective ambient persuasion installations.

We illustrate the approach through some examples, in particular some interactive objects that are currently being developed and/or evaluated. The systems developed employ technology like sensors, actuators and web services’ communication. They were primarily designed to provide stress relief at the office, but could be applied to other contexts and domains.

Author Keywords

Interaction design, ambient persuasion, sensor-based installations, ambient intelligence

ACM Classification Keywords

H5.m. Information interfaces and presentation. H5.2 User interfaces.

Introduction

Ambient Intelligence is a research area that aims at embedding the real world with digital technology capable of predicting and adapting to the users’ needs, in order to better fulfill those

needs [1]. Persuasive technology is defined “as any interactive computing system designed to change people’s attitudes or behaviors” [3]. In this position paper, we describe an alternative application area for persuasive objects, which we call “work style improvement persuasion”. Broadly speaking, this includes any kind of persuasive object or ambient display that can improve the way people work at the office.

We illustrate the approach by describing some proof-of-concept interactive installations and objects. The projects described in this paper make extensive use of technologies like distance and force sensors, LEDs and motor controls, LCDs, accelerometers, sensor-server communication, RSS feeds and internet servers.

Related work

The Ambient Orb [10] is a well-known, commercial example of a smart object particularly suited for office use. It consists of a frosted-glass ball that glows different colors to display real time stock market trends, traffic congestion, pollen forecasts, or any other information channel from a series of available ones like weather, wind speed, pollen, or traffic congestion.

Since office breaks often include time for coffee, we believe the MediaCup [11] should also be listed in this brief related work section. The MediaCup is an ordinary coffee cup augmented with sensing, processing and communication capabilities (which are integrated in the cup’s bottom). The goal is to collect and communicate general context information in a given environment.

Eye:: is a student project by David Chawei Hsu and Li-lu Chen, who observed that people working for an extended amount of time in an enclosed space, people (such as office workers) often have the need to find momentary relieves by opening windows to see, hear or reconnect with the outside spaces. EyE is an interactive installation that combines a real window frame, a digital display, and other outputs to create relaxing or surprising window-opening experiences to these office workers as if they are just a window away from these scenic places. This is an interesting way of providing stress relief at the office, although more evaluation is needed to obtain more clear conclusions.

Notifications and alerts are also part of a typical office experience. Ele-Phidget [12], an interactive elephant, is an

example of an ambient notification system for an audio chat program. When the user receives a message, the elephant turns around and faces the user. If the user pushes the elephant's stomach the user will listen to the message. When no messages are left, the elephant turns away. To record a message, the user squeezes the elephant's head and speaks into the elephant's trunk. A second squeeze stops recording and sends the message.

There is evidence that ambient displays can effectively persuade users to change their behaviors. DiMicco [13] describes an ambient visualization system called Second Messenger, which groups can use as a method for reflecting upon their own social interaction, as a means to gain a better understanding of it. Second Messenger also provides an automated method for gathering basic information about group interaction dynamics in office and work places. Experimental results indicated that the display influenced the amount an individual participates in a discussion and the process of information sharing used during a decision-making task. Although this project is not aimed at stress relief or at explicit ambient persuasion, it is a very interesting study of the power ambient displays have in a collaborative work setting.

Understanding the work experience

One of the key problems in today's fast-paced work experience is: interruption. Gloria Mark and colleagues present data from detailed observation from 24 information workers that shows that they experience work fragmentation as common practice [4]. Through extensive observation, they were able to discover issues like the fact that most internal interruptions were due to personal work, while most external interruptions were due to central work. Using empirical sampling methods and qualitative interviews has also proven useful for examining attitudes toward availability and interruption [6].

We studied a similar problem when observing work styles and work styles transitions in the context of a special kind of workers: interaction designers [9]. We observed that we could ease the user interface (UI) aspects of software development by giving both designers and developers tools that could transparently adapt to particular styles of work (or *work styles*).

We designed a model, called the work style model, for describing the

interaction designer's and software engineer's ways of working, as well as transitions between them. Based on that model, we devised, designed, implemented and evaluated tools that could support work styles and that could smooth the transitions between those work styles. What differentiated our design strategy from others was precisely the fact that our approach was specifically aimed at designing in order to support work style transitions.

This and other projects helped to found a new IFIP working group on Human-Work Interaction Design [9], which is committed to "promoting a better understanding of the relationship between work-domain based empirical studies and the iterative design of prototypes and new technologies".

Eventually all these work styles lead to a stressful experience at the office. And this, in turn, has lead to our interest in ambient persuasion. We are all familiar with work-related horror stories. Psychologists have studied the human behavior in the workplace, in particular how attitudes can change through persuasion and the costs of stress at the workplace [5]. As a result from extensive psychology research, which has started many years ago, people now dispose of a large number of principles on how to deal with stress at work.

Our premise in this position paper is that there is a huge potential for improving the human work experience by using ambient persuasion technology, and by carefully studying some of the principles for dealing with workplace stress.

Improving the work experience

The design examples we will present in this section are aimed at improving the work-at-the-office experience, although they could be used in other settings. The main purpose is not to create sound theories, but rather to have proof-of-concept installations and objects, which can then serve as the basis for experiences studying the influence of this kind of persuasive objects on the users' experience.

Ambient Persuasion for Stress Relief at the Office

Hans Selye [15] was one of the first to popularize the concept of "stress" back in the 1950s. Since then, psychology as well as medicine and popular culture have accepted stress as a negative fact of life. One of the techniques for relieving stress is known as the "Pilot in command" technique. Pilot training

involves coping with emergencies. In face of those critical situations, physiological changes occur, which encourage a narrow focus of attention on the "blood rage" necessary for survival. In a crisis, however, a pilot needs precise hand and foot movements, not gross physical strength, and he or she needs clear thinking, not the tunnel vision of rage. As a consequence, the "natural" survival skills triggered by an emergency can actually lead to a pilot losing control of the aircraft.

Therefore, some of the stress-relieving techniques that are based on this example involve (i) taking command of breathing, (ii) taking command of muscle tension, and (iii) taking command of cognitive processes.

Taking command of breathing – we believe – is a situation that happens very rarely at the office. The need to take command of muscle tension is unfortunately much more frequent, as Repetitive-Strain Injuries (RSI) become more and more frequent. Regarding (ii), simply being *aware* of which muscles are tense is already half-way to reducing potentially stressing situations. In this position paper, we argue that ambient persuasion displays could exploit this. Also, letting go muscle tension is the key objective. Again, we argue that ambient persuasion interactive installations could be used for stimulating muscle exercise.

Being aware of (iii) implies changing focused, negative thinking and self-defeating thoughts towards open, positive thinking and intuitive creativity. Again, we argue that interactive objects and ambient persuasion should strive to achieve this goal. The following sections briefly describe some of the prototypes we have been designing and evaluating in the light of this objective.

TouchMe - An Affective Frame

"TouchMe" is an affective picture frame. The basic idea is to have two affective picture frames connected to different computers and transmit "emotions" over the internet. Each affective picture frame has sensors and LEDs embedded, as illustrated in Figure 1. When the user touches the sensor in his/her affective picture frame, the system sends a message over the internet to the other affective picture frame that lights up the LEDs in that picture frame. This was our first prototype and is very similar to Lumitouch [14], except for the sensors which are more flexible in "TouchMe",

and the online community of “touchers” which we briefly describe in the next section.

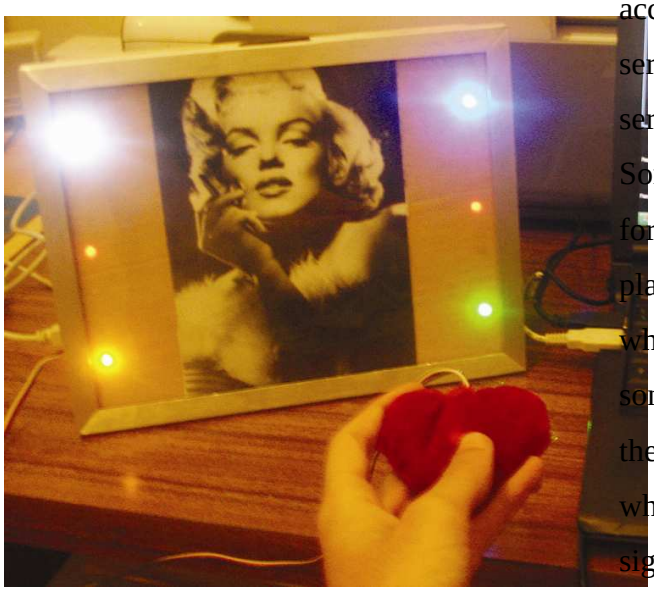

Figure 1: illustration of the Affective Frame and the Sensing Heart, altogether.

The affective picture frame hardware consists of a Phidget InterfaceKit 8/8/8, some LEDs as outputs (the prototype in the Figure has six of them), a basic switch (on/off), a force sensor and an infrared distance sensor.

The frame is connected to the PC via USB and is controlled by a program coded in Adobe’s Flash. The client program basically handles the phidgets inputs and converts them to a specific message so that it can be sent over the Internet to the other client program. The connection between Phidgets Interface Kit and the program is made by the Phidgets Webservice. The connection between the two affective picture frames over the Internet is accomplished through a free Flash server, the Smartfoxserver, which is a server for multiuser Flash applications. Some extra features were added. A force sensor disguised inside a heart plays a specific song on the other frame, when pressed; the idea was to play the song that every couple identifies as theirs. In a more detailed explanation, when a sensor is pressed, it sends a signal over the USB port to the application coded in Flash which handles that signal and converts it to a specific string. That string is then sent over the Smartfoxserver to the other users; the other application analyses the received commands and checks if it’s a Phidget command or simply a chat message: if it’s a chat message, it displays it through the interface shown in Figure 2. Otherwise it converts the string to a specific command, such as “light up all leds for 1 minute”.

TouchMe! – a community of socially attentive users

In his book “The Pursuit of Attention: Power and Ego in Everyday Life” [7], Derber explains how the human pursuit for attention is well alive, particularly in

America's competitive society. As the review for this book states, "Enough about me, let's talk about you: what do you think of me?", there are many techniques individuals use to turn the course of a conversation towards themselves. Another example of this is the "ego-surfing" phenomenon: surfing the Internet to find occurrences of our own name. Humans, as we know, like to feel they are part of a society, a community.

This lead to the development of a virtual community of "Touchers", or socially attentive users. The interface for the client program is shown in Figure 2. Besides being used for the sounds and music transmitted by the "TouchMe" affective frame, it also acts as a messenger-like program.

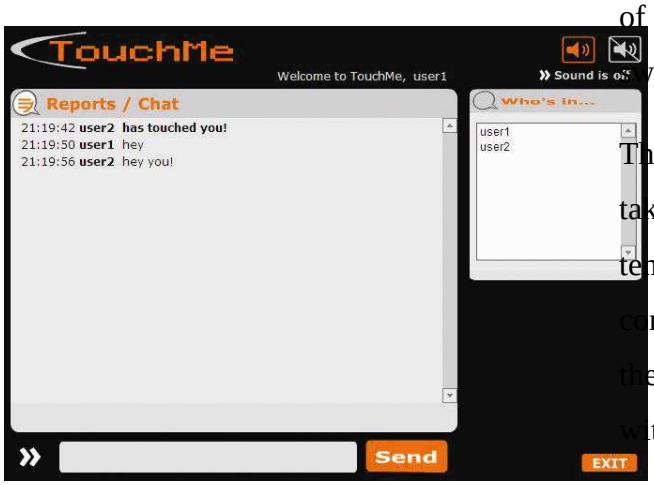

Figure 2: a screenshot of the TouchMe! Community, client user interface.

The Sensing Heart

The sensing heart is a prototype very similar to the heart presented in Figure 1. It includes an Arduino [3] wireless board that communicates the sensor information to the nearest Bluetooth-equipped PC. We use a pressure sensor to determine the strength the user is applying to the heart.

Following the previous "TouchMe!" prototype idea, the heart communicates the pressure action over the Internet to a desired user, who listens to a smooth sound which has frequencies and amplitudes related to how hard the heart was pressed by the other user.

A variation to this object includes an accelerometer instead of a pressure sensor. The effect is similar, but instead of pressing, the user interacts by swinging or moving the heart.

This object was designed in order to take advantage of relaxing muscle tension from time to time, which can contribute to relieve the stress, while at the same time maintain a connection with other remote user.

Ambient Smart Flowers

The role of nature in calming humans is well recognized. To exploit how this

role could be used in persuading the office worker to feel better, we developed the ambient smart flowers.

We employ artificial flowers that incorporate a motor that makes the flowers lean towards the floor or towards the user. Presence sensors are disguised into the flowers and are used to check if the user is sitting at his/her desk, working, or if he/she is leaving the office.

This way, the ambient smart flowers (Wow!Flowers)are aware of when the user is in the office desk and they look bright and happy when the user is sitting at the desk. When the user leaves, the flowers lean towards the floor, looking sad. This is a different idea that could be promising in improving the office experience, without being too much of a distraction.

Conclusions

All the prototypes described here are interlinked and are flexible enough to be used in a variety of places. Several combinations can be made, but the common thread is the ambient persuasion of office workers, towards a less stressful work experience.

Based on the recent informal evaluation of each of the examples described, we argue that there are many opportunities for innovation through the use of ambient persuasive interactive installations or objects.

However, more research is needed regarding the actual usage of this new generation of objects. A formal, extensive evaluation has to be undertaken in order to discover the hidden aspects of the influence this kind of objects has on the users' feelings. We believe this is a first step towards building new interactions, interactions capable of improving the users' experiences and work styles.

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APPENDIX B : WOW!TOUCHME QUESTIONNAIRE SAMPLE

Wow!TouchMe Questionnaire

1 Design

1.1 Do you think that the pig plush was a good design to transmit emotions over the internet?

○	○	○	○	○
Very bad	Bad	I don't know	Good	Excellent

1.2 The lighting eyes were a good choice?

○	○	○	○	○
Very bad	Bad	I don't know	Good	Excellent

1.3 The singing and the moving mouth were a good choice to act as an emotion output "display"?

○	○	○	○	○
Very bad	Bad	I don't know	Good	Excellent

1.4 The pig plush was a good and attractive object to have near the computer?

○	○	○	○	○
Very bad	Bad	I don't know	Good	Excellent

1.5 The heart to send a voice clip was easy and attractive to use?

○	○	○	○	○
Very hard	Hard	I don't know	Easy	Very easy

2 Wow!TouchMe Software

2.1 It was easy to install the script in your MSN?

○	○	○	○	○
Very hard	Hard	I don't know	Easy	Very easy

2.2 It was easy to install Phidgets Manager?

○	○	○	○	○
Very hard	Hard	I don't know	Easy	Very easy

2.3 The options and touch list were user-friendly and easy to use?

○	○	○	○	○
Very hard	Hard	I don't know	Easy	Very easy

2.4 Did you already had MSN Plus?

○	○	○
No	I don't know	Yes

2.5 Do you like being notified in the MSN when you receive a touch?

○	○	○	○	○
Hell no	No	I don't know	Yes	Very much

3 Emotions

3.1 Did you feel happy when you received a touch?

○	○	○	○	○
Hell no	No	I don't know	Yes	Very much

3.2 Do you think this could be a good way to transmit emotions over the internet to the loved ones?

○	○	○	○	○
Hell no	No	I don't know	Yes	Very much

APPENDIX B1 : WOW!TOUCHME QUESTIONNAIRE RESULTS

Question n.					
	Very Bad	Bad	I Don't Know	Good	Excellent
1.1	0%	0%	0%	25%	75%
1.2	0%	0%	0%	25%	75%
1.3	0%	0%	0%	0%	100%
1.4	0%	0%	0%	37,5%	62,5%
	Very Hard	Hard	I Don't Know	Easy	Very Easy
1.5	0%	0%	25%	50%	25%
2.1	0%	0%	0%	25%	75%
2.2	0%	0%	0%	50%	50%
2.3	0%	0%	0%	12,5%	87,5%
		No	I Don't Know	Yes	
2.4		37,5%	0%	62,5%	
	Hell No	No	I Don't Know	Yes	Very Much
2.5	0%	0%	0%	37,5%	62,5%
3.1	0%	0%	0%	25%	75%
3.2	0%	0%	0%	12,5%	87,5%

Wow!TouchMe Questionnaire results. Total questionnaires: 8.