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QUIET PLEASE!, AN EXHIBITION OF WORK FROM THE SMENMS PROJECT.

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Abstract

Quiet Please! was a collection of work which attempted to change our perception of how we view and interact with music and sound. This exhibition was the result of the Smenms project and our exploration of three broad disciplines: sound art, tangible music interfaces, and network music. We hoped to have people experience and interact with digital information in new and interesting ways.

Smenms: Towards a Shared Musical Environment for Non-Musicians proposes an investigation into the creation of collaborative environments that will allow for the ongoing sharing and creation of sound events (music). The goal of such systems is to provide an easily understood yet malleable environment that allows for creative expression and communication at a rich level. Current online collaborative music environments are geared toward traditional studio environments, use interaction metaphors unfamiliar to many, and require levels of expertise non-musician non-expert participants would not possess. This proposed work will allow for participation in an ongoing musical performance introducing new metaphors and physical interfaces that are both accessible and expressive.

This thesis describes the design and the outcomes of the smenms project and the implementation of the Quiet Please! installations. The Quiet Please exhibition was held from January 8 – 29, 2005, in Hsinchu, Taiwan.

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1. Introduction

A great deal of work has been done within the realm of this project. If we think of tangible interfaces alone there have been numerous examples. One of the problems that can be identified is the amount of similarity in the metaphors used to allow people to physically manipulate music and sound. There is much room for further exploration of all kinds of objects to act as intermediaries between the computer and person. As well, despite being a networked society and the Internet being as much a part of our lives as any other modern technology device, scant attention has been given to networking all these wonderful musical tangible interfaces together. Let's allow a person in Des Moines pick up her tangible musical instrument and play with an "AOL buddy" in Tokyo. In addition to thinking about new interfaces for music and sound play, I have spent considerable effort on thinking about sound itself and how our environment can change the experience – this environment today necessarily includes the Internet.

1.1 Personal Information

I first started music study at a young age through my school band and music programs. In high school I started serious private study with James Montgomery at the University of Prince Edward Island (UPEI). I attended UPEI in 1985 in the music education program and was awarded entrance to the deans list for academic achievement. After one year at UPEI I spent 3 years at Humber College of Applied Arts in Toronto in their Jazz and Commercial Music performance program. While there I studied under the tutelage of Don Johnson (Toronto Symphony, CBC Radio Orchestra), Art Maiste (Montreal Symphony), Pat Labarbera (Elvin Jones), and Ron Collier (Duke Ellington). I was awarded the "Brass Award" for outstanding ability and had the honour of performing with many of their top ensembles including Lab Band 1. After Humber College I attended St. Francis Xavier University, a small liberal arts university in Nova Scotia, where I completed a Bachelor of Arts in Music with a jazz pedagogy concentration. I also studied privately at the Royal Conservatory and with leading artists in the National Ballet, Boston Symphony Orchestra, Toronto Symphony, Boss Brass, and Woody Herman Jazz Ensembles. Though I studied composition and arranging my focus was primarily performing.

During my time in school and afterward I enjoyed the good fortune of a varied schedule as a side man, leader, and producer. I was a freelance/contract artist in Toronto and Atlantic Canada for over 12 years. At the age of 16 I started my performing career with the Island Brass first as sideman than as leader, securing government funding for a daily performance schedule. Later my work ranged from playing with the Toronto Pops to a theme park clown act. I had live recordings with CBC Radio and television, CTV/ATV, and Much Music. Studio sessions with the Ontario Film Board, some jingles, and numerous sessions with local independent artists. I was a section trumpet player with R&B, Latin, and Pop horn sections in studio sessions, club dates, and touring. I played in small ensembles and as a soloist with jazz quintets in college, performing in small clubs and at the Atlantic and Beaches Jazz festivals. Though performing opportunities were limited my greatest love was the sound of playing 20th century works by the likes of Copland, Ives, Hindemith, Honegger, Poulenc, Satie and Tomasi.

Before attending Chiao Tung University I was a largely self taught designer. Since starting in the Internet industry in 1997, I have had a hands-on role in almost every aspect of Web development, from interface design and programming to content development and high-level strategy. Currently my professional activities include creative direction for projects large and small, integrating content, graphic design, and technology from a user-centered perspective.

1.2 Motivation and Goals

The Sme(n)ms project was inspired by my both my past personal struggle with playing musical instruments and the desire for my new born daughter to be able to express herself through sound and music as quickly as possible. I see my work as being guided by three general questions. How can tangible interfaces reflect the potentials of digital music and sound while maintaining the musical mappings and intuitive playing style found in acoustic instruments? Can creating new intuitive interfaces bring people back into the music making process? What are some of the potential rewards of networking musical instruments?

As my daughter Catriona developed greater control over her body, developing the ability to stand and to grasp objects, she started to become a willing participant in sound and music making activities. At first her participation was limited to simple waving of her hands while later she would try to recite the melody I was singing with her voice. As these first few months passed I started to teach her to use the environment around her as her own personal musical instrument.

The first of these homemade instruments were the large containers of water we had in our kitchen. These were ideal because first they were at 36 cm in height a near perfect size for her to be able have a good downward range of movement. Secondly because some were full of water and some were not there were a variety of possible sound results. I continued this particular activity for a few weeks, trying to teach basic rhythm but mostly succeeding in getting her excited about creating sound.

After introducing Catriona to the water bottles I eventually started teaching her to use a spoon as her mallet and the pots and pans as her drum. We would have nightly noise making sessions that thrilled her to no end. I gradually expanded the surfaces she could make noise on to just about every surface available to her, doors, walls, floors, tables, chairs were all becoming her instruments.

As she now had good basic motor function I started purchasing traditional percussion instruments which she found almost equally as interesting. But like many children she had a fascination with sound, any sound, and many of the toys I purchased were objects of sound first and other intended uses came second.

It was working with her during this period that I realized the need to be able to give a toy that she could manipulate that would create not only a seemingly infinite number of sounds but could also allow her to start expressing herself musically when she was ready. I didn't want her to have to wait join a music program, I didn't want her to be limited to just the sound of one instrument, and importantly I didn't want her to have to struggle with the difficulty apparent to learning many musical instruments in the efforts to make music.

Music of course has commonly been called a universal language of its own. Music and sound is everywhere. The city is a symphony of sound: in elevators, sports arenas, cars and kitchens, downloaded and remixed at will, an accompaniment to our everyday lives. Luigi Russolo, envisioned "entire symphonies composed of the sounds of everyday life," including "...the muttering of motors that breathe and pulse with an undeniable animality, the throbbing of valves, the bustle of pistons, the shrieks of power saws, the starting of a streetcar on the tracks, the cracking of whips, the flapping of awnings and flags." (The Art of Noises,1913)

Sharing, sampling and remixing of music has emerged as one of the most popular activities online. And the sharing of music on line is in many ways a beginning contrast to how we currently share music in the real world, music has become an entirely passive experience. We simply broadcast music and we sit and listen to it. Music used to be an entirely interactive event. As long ago as the Elizabethan era it was entirely common for the people to be involved in the creation of music. Even today there is some evidence of some interactivity in music which can be witnessed in gospel music and in the aural tradition of American jazz.

But despite this seemingly wondrous sonic environment that should elicit wonder, like I found my daughter Catriona was experiencing, much of this has become a comforting background that dulls—rather than intensifies—our imagination and curiosity. It seems that the more exposure we have the less open we are to be touched and transformed by music and sound.

New tools for expression are the key to bringing people back into the performance of music, making music once again the interactive social activity it could be. These new tools should be adaptable to any level of skill or experience, enhancing expressive power for the experienced while permitting amateurs of all ages to learn and create.

Mark Weiser's vision of Ubiquitous Computing proposes a world in which computational services can be naturally and "invisibly" integrated into our physical environment. Stimulated by these ideas, I decided to start by looking towards common physical devices of the last few millennia in order to invent ways of re-applying these objects augmented by digital technology for the sole purpose of creating a body of work that would allow for new ways of interacting with sound and music. My goal was to design a set of interfaces that are transparent and seamlessly weave themselves into the fabric of everyday life. The interface must be expressive and accessible with the minimum of mental effort, and must allow for a kind of "purposeful purposelessness" [John Cage] - a type of playing with music and sound that is in turn explorative and engaging, intuitive and enjoyable. I wanted to create a collaborative environment that allows for the ongoing sharing of sound events. This environment must allow for expression and communication at a rich level, allow for a recording and indexing of past performances, and allow for a "snapshot" of the current event.

Initially the final outcome was to be an installation called a music box. Geared towards children, the music box would allow them to interact with their environment to create their own musical soundscape. It was to employ interfaces able to manipulate specific creative parameters in the pre-created sound objects. The installation was to be behaviour driven - creating new metaphors other than the traditional knobs, buttons, and keys. Traditional musical instruments generally suggest traditions and a seriousness that quickly precludes non-musicians from using them.

Another final outcome that was suggested was a 'kitchen environment' where all the objects normally found in a kitchen became themselves musical instruments. This installation was influenced by the social music making setting that I witnessed in my youth growing up in Atlantic Canada. These kitchen jam sessions helped provide one of the few means of entertainment and social activities for many communities, especially those in rural areas where people lived a far distance from one another. Our re-creation would have taken into account the modern social context for communication, sharing music, and community building – namely, the Internet. One of the advantages that the social settings had in my youth over our modern incarnation was the ease in which people could participate in music making sessions. Every pot and pan, every surface, every tool became a potential musical instrument. People were able to use a device they were most familiar or comfortable with to join the music making session. The tapping of pots and pans, beating of hands on the table, and singing all helped form a compliment to the more experienced members playing more traditional musical instruments.

1.3 Project Duration and Scope

The Smenms project is a broad investigation which started in June of 2004 and resulted in an exhibition called Quiet Please! on January 8, 2005. The exhibition itself ran for 3 weeks at the Hsinchu Railway Art House.

The initial proposal called for the creation of two installations in separate locations. Over time the scope was broadened to include the creation of 7 installations and 1 product concept. Since the chosen gallery was new and had limited resources we took a large 1500 x 950 cm empty space and installed a fixed line broadband internet connection, LAN, electrical, lighting and walls. It was an enormous undertaking, under considerable time and monetary constraints.

Further detail about the exhibition itself can be found in section 3.

1.4 Project methodology and process

In starting the project I immediately realized the need for help in two areas: engineering and project management. These roles filled by colleagues Chientai Chen and Hsiang-Lan Hsih were invaluable for the sourcing of resources but also for the initial ideation stages of the project. I wanted people to both help to create ideas in support of my goals and to provide some outside criticality on the viability of my work. They were able to join the project by the time I was ready to start the second phase of the project, the process of which I describe next.

As the project timeline was very tight I co-opted a process for product development proposed by IDEO, a design firm with offices in San Francisco, Chicago, Boston, London, and Munich. They employ a process they call the "IDEO Way". It consists of five steps, which I briefly paraphrase below with my explanations:

1) "Observation – Using shadowing, behaviour mapping, consumer journey, camera journals, user interviews, storytelling, and focus group techniques to understand the potential customer or user for the product.
2) Brain Storming – An intense, idea generating session, which lasts no more than an hour.
3) Rapid Prototyping – Mocking up working models as quickly as possible with an emphasis on visualizing the solutions.
4) Refining – At this stage the number of prototypes are narrowed down to a few possibilities. Brainstorming is again a valuable tool in finding the best options.
5) Implementation – Using engineering to actually build out the plans." (Businessweek, 2004)

The installations that we produced for the exhibition were initially conceived as polished prototypes and examples of ideas we discovered in the brainstorming and rapid prototyping stages of the IDEO process. It was only as the exhibition's opening approached that I refined the prototypes to be acceptable art for display. I didn't employ the observation stage of the process, instead focusing on background study the results of which I discuss in chapter 2. The two techniques that I found most valuable in creating ideas were IDEO's brainstorming method and the process I employed for rapid prototyping. IDEO's brainstorming method is quoted below:

"Seven Secrets for Better Brainstorming

1) **Sharpen the focus**

   Good brainstormers start with a well-honed statement of the problem. This can be as simple as a question. Edgy is better than fuzzy. The session will get off to a better start-and you can bring people back into the main topic more easily-if you have a well-articulated description of the problem at just the right level of specificity.

   We've also found that the best topic statements focus *outward* on a specific customer need or service enhancement rather than focusing *inward* on some organizational goal. On the other hand, a series of more specific, customer-focused brainstorms on topics like "How can we accelerate the time-to-first-result for customers searching via dial-up modems" could uncover innovations that might ultimately yield the competitive edge you are looking for.

2) **Playful rules**

Don't start to critique or debate ideas. It can sap the energy of the session pretty quickly. You need a way to turn aside critiques without turning off the critiquers completely. At IDEO many of our conference rooms have brainstorming rules stenciled in six-inch-high letters on the walls, for example, "Go for quantity," "Encourage wild ideas," or "Be visual." Not willing to mark up your walls?

3) **Number your ideas**

Numbering the ideas that bubble up in a brainstorm helps in two ways. First, it's a tool to motivate the participants before and during the session ("Let's try to get a hundred ideas before we leave the room") or to gauge the fluency of a complete brainstorm. Second, it's a great way to jump back and forth from idea to idea without lasing track of where you are.

4) **Build and jump**

Watch for chances to "build" and "jump." High-energy brainstormers tend to follow a series of steep "power" curves, in which momentum builds slowly, then intensely, then starts to plateau. The best facilitators can nurture an emerging conversation with a light touch in the first phase and know enough to let ideas flow during the steep part of the ideation curve. It's when energy fades on a line of discussion that the facilitator really earns his or her keep.

Try building on an idea. Encourage another push or introduce a small variation. Or take a jump, either *back* to an earlier path you skipped by too quickly or *forward* to a completely new approach. Whatever you do, try to get into the next power curve and keep the energy up.

5) **The space remembers**

Write the flow of ideas down in a medium visible to the whole group. There are many emerging digital technologies for group work, but we have had great success with extremely low-tech tools like Sharpie markers, giant Post-its for the walls, and rolls of old-fashioned butchershop paper on the tables.

Cover virtually every wall and flat surface with paper before the session starts. And you may find there's a certain synergy in physically moving around the room writing down and sketching the ideas. As you rapidly capture the team's ideas, make a mental note of ones that are worth coming back to during a build or a jump. When you return to the spot on the wall where that idea was captured, spatial memory will help people recapture the mind-set they had when the idea first emerged.

6) **Stretch your mental muscles**

People are busy. Time is short. Is it worthwhile to "burn" some time at the beginning of a brainstorm doing some form of group warm-up? Maybe. But that "maybe" rapidly becomes a "yes" in certain circumstances:

- When the group has not worked together before
- When most of the group doesn't brainstorm frequently
- When the group seems distracted by pressing but unrelated issues

One type of warm-up we practice is a fast-paced word game simply to clear the mind (Zen practitioners call it "beginner's mind") and to get the team into a more outgoing mode. Another warm-up is to do some content-related homework.

7) **Get physical**

Good brainstormers are extremely visual. They include sketching, mind mapping, diagrams, and stick figures. You don't have to be an artist to get your point across with a sketch or diagram. Leave your performance anxieties at the door and jump in with whatever visual tools you have available.

But the best brainstormers often get physical. We move beyond two dimensions and push for three. The first way we do this is to bring in everything but the kitchen sink (and we've brought the sink, too, when it was relevant). The second way we get physical is to have materials on hand to build crude models of a concept: block, foam core, tubing, duct tape, whatever might be useful. The third physical approach is "bodystorming," where we act out current

> behavior/usage patterns and see how they might be altered. We've bodystormed on products ranging from vending machines to car seats, where our skits and scenarios pointed to all kinds of opportunities for improvement." (Art of Innovation, Kelly, pg. 56-62)

Of all the rules and steps they adhere to the most valuable in this particular project was to accept and record all ideas, move the notetaking to the walls, and allowing the team members to get up and act their ideas with make believe prototypes. These really removed the common barrier inherent in so many teams, the idea that only some people are creative. Those that feel they are not tend to be very quiet when they actually have so much to offer.

Our brainstorming meetings were not without problems and some the most serious challenges matched what was said in the book Art of Innovation by Tom Kelly where he details Six Ways to Kill a Brainstormer. Out of the six he details two caused me the greatest difficulty. First was the tendency to allow and ensure that the boss speaks first.

> "If the boss gets first crack, then he's going to set the agenda and the boundaries, and your brainstormer is immediately limited. I know of one Silicon Valley boss who eagerly launched a brainstorm saying he was looking for some great new ideas. But unfortunately, he followed that enthusiasm with a room-silencing caveat: "Oh, and every new idea has to be patentable. And something we can manufacture." In that setting, nobody is going to suggest anything even remotely "wild." Try sending the boss out for coffee. Or doughnuts."

Conscious effort was required to get the team, which later grew to only five, to speak out first. I wanted an environment where we could all speak our ideas freely without the usual hierarchy so present in Taiwan corporate culture. The other potential derailment to a efficient session was the illusion of expertise. Engineers are not supposed to have idea and artists are not supposed to be practical. All are common myths that need to be broken down and eliminated.

> "Let's see, do I have a materials expert, an engineer, a software guru, and the V.P. of marketing? In brainstorming, don't be an "expert" snob. Bring in someone from manufacturing, who knows how to build things. Invite a

> customer service rep with lots of field experience. Find someone who reads a lot of science fiction. They may not have the "right" degrees, but they just might have the insight you need."

Lastly, there seems to be a tendency to want to do anything creative in special surroundings. At any announcement of a "ideation" session immediately someone would suggest to have the meeting at Starbucks or another very public environment. We tried it once but the only thing accomplished was the drinking of coffee. A proper environment where all the tools are at hand and where we can act out our ideas without worrying about the attentions of others is essential.

> "Brainstorming at ski lodges and beach resorts can be counterproductive. Do you want your team members to think that creativity and inspiration only happen at high altitude or within walking distance of an ocean? Don't get me wrong: Off-sites are fine. But remember, you want the buzz of creativity to blow through your offices as regularly as a breeze at the beach."

Ideas

After coming out with a large number of usable concepts and ideas I created a simple categorization of these ideas, which would serve as the driver for the rest of our schedule. After further refinement only a number of these ideas were prototyped and included into the exhibition. There were a couple as well that were conceived later at the last minute (Traffic 1 and Windchimes).

Prototyping

The initial date we were given for an exhibition in support of the Industrial Technology Research Institute's Creativity Lab opening was in the middle of September. Though this venue for the exhibition of my work was to eventually be replaced with a solo exhibition, I set up an initial monthly schedule that would allow for the creation of two art installations, allowing people at each location to collaborate in a real time music performance, by that initial due date.

The process was iterative and broken down into three different cycles, each culminating in a working demo, with a fourth cycle where the final installation design will take place. The three different cycles' interactions are briefly outlined below.

Cycle 1

During this period we focused on creating a tangible user interface (TUI) that performs a simple start/stop function. The participant will control the fading in and out of a music stream in real time. In this and the other cycles the goal is to rapidly develop interfaces using sensors at hand. Time is a definite factor in our choices and it is part of the challenge to find readily available materials to adapt to our needs.

Cycle 2

This cycle produces a TUI that performs a simple start/stop function but also controls a sound variable (timbre, pitch, etc.).

Cycle 3

In the previous two cycles the sound has been controlled locally on a PC which is hidden from view. In this phase we focus on refining the previously developed TUI's and create the remote environment that will allow for the separate installations to communicate with each other.

While eventually we abandoned this cycle it did instill the mindset of constantly demoing our work, forcing me to create prototypes as quickly as possible, and allowing the focus on the end product vs. just paper sketches.

Production

All music related production was original work and accomplished with the following equipment: Apple Macintosh G4 desktop and laptop, Logic Pro 6, Ableton Live, Reason, Peak 4, M Audio Oxygen 8 midi controller, and Beyerdynamic 880 headphones.

2. Related work and study

The following are elements of study and prior work that contributed to the exhibition outcomes.

2.1 Sound and audio interfaces

Sound is one of our most sophisticated senses. From the time we are babies our entire world is filled with sounds designed to stimulate our behavior. We grow to expect pleasure or annoyance as were are introduced to surprising new sounds as well as established ones. It is the primary means by which most of us receive data, information, and knowledge. Sound has a variety of forms - voice, music, effects, nature, or other communication forms - and these can be incredibly rich, complex, and subtle. Yet most sound that we experience on a day-to-day basis goes unnoticed.

Sound can be distinguished from noise by the simple fact that sound can provide information. Sound answers questions; sound supports activities for tasks, so sound is inherently useful. Consider the information provided by the click when the bolt on a door slides open, the sound of your zipper when you close a pair of pants, the whistle of a kettle when your water is finished boiling, the sound of a river moving in the distance, the sound of liquid boiling, of food frying, and the sounds of people talking in the distance. In the workplace there are the sounds of keys being pressed on a computer keyboard. Natural sound is as essential as visual information because sound tells us about things we can't see and it does so while our eyes are occupied elsewhere. Natural sounds reflect the complex interaction of natural objects; the way one part moves against another, the material of which the parts are made. Sounds are generated when materials interact and the sound tells us whether they are hitting, sliding, breaking or bouncing. Sounds differ according to the characteristics of the objects and they differ on how fast things are going and how far they are from us. (Bill Gaver).

Sound is very much an integral part of our life, and yet the devices and "virtual" spaces in which we spend an ever increasing amount of time are silent.

"My main complaint (about modern interfaces) is that metaphor is a poor metaphor for what needs to be done. At PARC we coined the phrase 'user illusion' to describe what we were about when designing user interfaces. There are clear connotations to the stage, theatrics, and magic, all of which give much stronger hints as to the direction to be followed… should we transfer the paper metaphor so perfectly that the screen is as hard as paper to erase and change, clearly not." - Alan Kay

Even though we have two primary senses, hearing and visual, most current interfaces today are primarily visual. As vision and hearing are fundamentally different, there are some distinct advantages to incorporating audio to the user interface of online environments. There's magic when you use computers, there's magic when you open a web browser and interact with the user interface. This magic derives from the fact that computers aren't tied to the old analog world of objects. Computers can mimic that world, of course, but they are capable of performing and adopting new identities and performing new tasks that have no real world equivalent whatsoever. People who love computers and love the web get hooked on this magic; get hooked on this range of possibilities. They don't get hooked on computers because they remind them of real world tools, or remind them of a toaster. They get hooked on using computers because their machines do things that they never thought were possible. Interface design should reflect this newness in this range of possibility. Audio interfaces can help raise interfaces to these new levels.

Doug Enklebart is considered 'the father' of the modern interface. After being haunted by the image of Vanoveer Bushes Memex machine as described in his seminal essay called 'As You May Think', Enklebart went on to create the first (what we could call) bit mapped visual interface which contained a number of breakthrough innovations including the principal of direct manipulation; where one thing was to represent another and allow users to have some control over that particular thing as seen on the screen. An important part of that for him was that you were given an illusion, an actual illusion that things were happening. Creating illusion is a key part of interface design.

What exactly is an interface? An interface in the simplest sense is software that shapes the interaction between user and computer. The interface serves as a kind of translator mediating between the two parties making one sensible to the other. In other words the relationship governed by the interface is a semantic one characterized by meaning and expression rather than physical force. So for computers to create this illusion, this aforementioned magic, they must represent themselves in a language that the user understands. Sounds and music are something that people can interpret and understand fairly well, even if they don't have the vocabulary to express their understanding (and I do have a certain assumption that people can differentiate between sounds if they are different enough). There are some experiments by Brewster (1998) that indicate this, however there doesn't appear to be a great deal of experimental conclusions in the field of auditory interfaces but there do seem to be some general traits that characterize sounds that are useful auditory interface material and there is some research to provide some approaches for their use in software based interfaces. Obviously in order to construct a good interface, a lot of specific research and testing is necessary and considerable amounts of creativity are needed to design a useful and aesthetic auditory interface.

Computers, mobile phones, and other machine interfaces primarily present information by visual means, but while displaying this content visually is generally accepted as being convenient there are some crucial limitations to using this approach alone. There are two central issues in the general problem of the display of information visually. One is the need to display three more dimensions of information on two dimensional displays; the other is the available resolutions for displays of information and this is evident in the fact that all display methods tend to be evaluated on the basis of resolution (Tufte 1983). So size of the display plays an important factor in the amount of information that can be conveyed. People always seem to want of course the smallest and lightest electronic devices and of course one efficient way of decreasing the size of these portable devices is to decrease the size of the display. Many of Sony's laptops and other manufacturers laptops gain their portability by dramatically reducing the size of their LCD screen. Of course, in the case of some electronic devices, one way to decrease the size of the device is to remove the screen or make it so small that it becomes an unessential part of information delivery. This is one instance where it is possible to deliver information aurally instead of visually. Auditory interaction is necessary, for example, when people want to communicate with computers through a telephone. According to Brewster, 1998 telephone based interfaces are becoming increasingly important for human machine communication. Telephone based interface is very common for booking tickets or paying utility bills. As well, an example which will be used more than once, the mobile phone, has perhaps one of the smallest visual displays and a great deal of information is delivered to the user of this device aurally.

Another issue with visual displays is that the user must focus on the display to obtain the information. This would be of particular interest when designing task based interfaces, like an e-commerce shopping cart, where the user might be distracted while trying to complete their task, depending on their environment at any given time. Auditory feedback enables the user to look away from the device while she is using it. The website user is freed to do more than one task at a time -- while completing the shopping cart task she can also focus on talking on the telephone, looking after the children, or grabbing a cup of coffee while waiting for the transaction to process. Auditory interfaces can also be a useful alternative to visual feedback. In terms of online narrative if you want people focus on the text you could convey a sense of calm, a sense of nature through sound without resorting to elaborate visual interface. Obviously you can’t in terms of mobile devices design for every possible scenario for use. Mobile devices are not the focus of this paper but they exemplify some of the resistance to adding sound to interfaces in that people consider sound through a computer to be equivalent to noise. You see a great deal of backlash in terms of mobile devices in the public's fear relaying the necessary auditory information but at the same time creating noise. At the same time you must account for the number of occasions when visual feedback would be required, where a noisy room would not allow for the use of sound. Still it seems that auditory feedback despite some negative reactions has benefits and has been overlooked in many machine interfaces.

Vision and hearing are our primary senses for obtaining information. Hearing has often been seen as the secondary sense as it seems that in many situations hearing simply tells us where to turn our eyes (Gaver 1997). It is important to note that sound is a unique medium which provides information that vision cannot.

Some of the ways that sound is unique are as follows:

- Sound can provide information about the interior of an object. Our ears perceive patterns of moving air from vibrating objects and sound can carry information about the consistency and hollowness of objects.

- Sound also communicates information very quickly (Brewster 1998)

- "Sound exists in time and over space, vision exists in space and over time" (Gaver 1989)

- Sound is not bound to a specific location

A drawback is that one cannot turn away from sounds nor can one turn off our ears to unpleasant sounds.

Hearing and vision compliment one another quite naturally in our physical environment as they do in multimedia, film, and other created environments. In fact sound design is a well-developed practice in film. Within 30 years of the introduction of soundtrack to cinema, sound has become an essential element of the understanding of film. Compared to film of course much of the use that we see of sound in interface design is very elementary. Multimedia titles and games are perhaps the notable exceptions. People may prefer to communicate face to face but other forms of communication like instant messaging are showing to be quite popular in the workplace and despite increases in the complexity of the conversation people do not appear to be switching communication modes (Isaacs 2003). In this example the current use of sound mirrors much of what is practiced in computer interfaces today which little sound reinforcement and only sounds that are commonly limited to various types of signals; buzzes, beeps, and general alert sounds commonly used to indicate alarms, message arrival, and extreme events. Other types of signals provide simple feedback when you have been successful in certain tasks such as when buttons are pressed to turn on the computer, a message has been sent, and in the case of the MacOS when a window has been successfully hidden. There are events that are not normally associated with sound. Brewster (1998) has investigated the use of sound as a provider of navigational cues in menu hierarchies. These menu hierarchies are common structures in computers, websites, mobile phones or telephone-based interfaces. An example of particular interest, Gaver (1997) claims that another little explored area is to use sound for communicating ongoing processes. Auditory interfaces would grow extensively if ongoing processes were to generate sound. These sound types would need to be discrete and naturalistic. The sounds employed by instant messaging applications are not naturalistic sounds and as such reveal little hidden information. The sound is as annoying as it is informative (Norman, 1988). By skillfully designing these interfaces this can be avoided.

2.2 Approaches to the design of sounds

Barrass (1997) describes 7 types of approaches to the design of sounds that in particular support information processing activities - syntactic, semantic, pragmatic, perceptual, task-oriented, connotative, and device-oriented.

"The syntactic approach focuses on the organization of auditory elements into more complex messages. The semantic approach focuses on the metaphorical meaning of the sound. The pragmatic method focuses on the psychoacoustic discrimination of the sounds. The perceptual method focuses on the significance of the relations between the sounds. The task-oriented method designs the sounds for a particular purpose. The connotative method is concerned with the cultural and aesthetic implications of the sound. The device-oriented method focuses on the transportability of the sounds between different devices, and the optimization of the sounds for a specific device" (Barrass 1997).

There are many ways to go about mapping sounds to information, and many factors to consider. Instead of going into detail about Barrass's 7 types, touching on much the same information but in a simplified form, Gaver's (1997) examination of 2 different strategies for the usage of sound may be better suited to this paper. One possibility he discusses is to base the interface on sounds, the origins of which are *analogous* to what they represent. These would be characterized as auditory icons and are based on everyday sounds. The other strategy, contrary to the first, is to use sounds that are arbitrarily linked to what they represent. "Ear cons" is a commonly held term for these *symbolic* sounds. An ear con is a musical sound that can be created from any sound source. A compromise between the iconic and symbolic strategies produces *metaphoric* or "representational" (Brewster 1998) sounds, which means that they share an abstract feature with what they are to represent. An example of a sound metaphor would be to use a high-pitched sound to represent a high spatial position on the screen. Using a low sound pressure to represent a far distance would be an iconic relationship as this is what would happen in the real world. The boundaries between these three types can be difficult to distinguish.

There are a number of advantages to using auditory icons in interfaces. Gaver (1997) states that iconic sounds are easily learned and remembered, though they may not be entirely intuitive. When you combine auditory and visual interfaces, it is ideal to have both icons rely on the same analogy, thereby by producing the most comprehensive hybrids. In Gaver's (1989) Sonic Finder for Macintosh computers, he grouped auditory icons into "feedback families". This operating system used "wooden" sounds to indicate interaction with text files. Selecting a text file makes a tapping sound, erasing it would create a splintering effect, and etc. Another possibility introduced in the Sonic Finder was the parameterising of auditory icons where one sound quality or parameter corresponds to the feature of the selected object. In his Sonic Finder, the pitch of the text file sound is parameterized to indicate size, so that selecting a large text file would result in a tapping sound with a lower pitch and selecting a small text file would result in a higher pitch.

A possible problem with auditory icons is that it may prove difficult to find suitable iconic sounds for all events in an interface, as they may not correspond to a sound-producing event in the real world. Compromises would produce inconsistency. Norman (1990) stresses the importance of developing a conceptual model that is understandable to the user. A well-designed interface should have as few interpretation strategies as possible. Another problem of course is that sounds from the most realistic mappings might not be suitable, as the user might get confused between the interface and the everyday sounds around her. In large interface sets it might prove challenging to find enough varied sounds that do not interfere with one another and the environment in which they will be used.

Symbolic sounds are arbitrarily mapped to what they represent and do not have to be limited by any similarities. Every ear con can be designed with emphasis on its aesthetic qualities, which is difficult when developing auditory icons. Since these symbolic sounds can be freely designed it opens up greater possibilities for musical interfaces that may be more pleasant and less tiring. As well, music provides for a sophisticated system for the manipulation of groups of sounds (Gaver 1997). When designing a musical interface, complex information can be conveyed by sounds that are parameterized in many dimensions.

While the approaches to mapping information to sounds outlined above may, at least in the case of symbolic sounds, be fine, Barrass (1997) has proposed a more comprehensive method which builds on Scaletti's definition of sonification. It has proven to be an approach suitable for my needs.

2.3 Tangible music interfaces

"Any sufficiently advanced technology is indistinguishable from magic". (Arthur C. Clarke)

For a person transported here from the 19th century, our world of trans-continental flight, plasma tv's, mobile phones, and pocket pcs would seem magical. To our technologically blasé generation there is little magic left in much of technology. We easily forget that we live in a world so different from that of the 19th century that a time-traveler would probably experience it as a different universe. We have lost that wonder and sense of discovery that we used to feel when experiencing technology. While adding sound to objects and interfaces is an important element to regaining this magic, enabling people to directly manipulate digital information in their environment will do even more. Imagine escaping the screen and making music with the objects in your livingroom. Imagine objects such as pillows, connected to the internet, talking to someone else's pillows, both of you making beautiful music together with an interface that you can feel and understand. Pillows sounds fanciful but that may just be the point.

PC's with Internet access create the experience of a virtual environment "inside" the computer. The screen represents the border between "the real" and "the virtual". Since Weiser's (1991) vision to push computers into the background in such a way that they became “invisible” in use, much research has been done on moving the user interface out of the screen and into the physical environment of the user, or as Ishii and Ullmer put it: “to change the world itself into an interface” (Ishii, H., and Ullmer, B, 1997).

It is this usage of the tangibles around us that can help to bring back a feeling of wonder, familiarity, and define a new relationship between computer and user. These new relationships are especially important when one considers using computers for music and sound. When one is given a musical instrument there is a sense of wonder and discovery in discerning how this “interface” will work and sound. Outside of some children’s toys one seldom feels this same emotion when working with a PC to create music. But it’s the limited nature of some aspects of a traditional musical instrument and its extremely high barrier to entry that we are trying to eliminate by using digital tools.

It’s important to define exactly what I mean by this term Tangible and Tangible Interface. It is by now a fairly well known and researched field but I will include this baseline definition to ensure a common understanding because I believe how others define things can provide directions for our own work. The most widespread definition of Tangible interfaces is provided by Hiroshi Ishii, the head of the Tangible Media Group (TMG) at the MIT Media Lab, “Tangible interfaces give physical form to digital information, employing physical artifacts both as representations and controls for computational media. TUIs couple physical representations (e.g., spatially manipulable physical objects) with digital representations (e.g., graphics and audio), yielding interactive systems that are computationally mediated, but generally not identifiable as “computers” per se ” (Ishii, H., and Ullmer, B, 1997).” It is worth noting that the “tangible” term derives from the Latin words “tangibilis” and “tangere,” meaning “to touch.”

George Fitzmaurice on Graspable User Interfaces in his thesis of the same name:

> “A Graspable UI design provides users concurrent access to multiple, specialized input devices which can serve as dedicated physical interface widgets, affording physical manipulation and spatial arrangements. Hence input control can be "space-multiplexed."

That is, different devices can be attached to different functions, each independently (but possibly simultaneously) accessible. This, then affords the capability to take advantage of the shape, size and position of the physical controller to increase functionality and decrease complexity. It also means that the potential persistence of attachment of a device to a function can be increased. By using physical objects, we not only allow users to employ a larger expressive range of gestures and grasping behaviors but also to leverage off of a user's innate spatial reasoning skills and everyday knowledge of object manipulations. These physical artifacts are essentially "graspable functions" -- input devices which can be tightly coupled or "attached" to virtual objects for manipulation, or for expressing actions. These artifacts need to have spatially-aware computational devices."

Two proposals seem most promising for an understanding of the characteristics of tangible interfaces. Both are relevant here. Ullmer and Ishii stress seamless integration of representation and control.

There are 4 characteristics concerning representation and control:

1. Physical representations are computationally coupled to underlying digital information.
2. Physical representations embody mechanisms for interactive control.
3. Physical representations are perceptually coupled to actively mediated digital representations. (visual augmentation via projection, sound...)
4. Physical state of tangibles embodies key aspects of the digital state of a system. (TUIs are persistent: turn off the electrical power and there is still something meaningfull there what can be interpreted)

And:

- Tangible interfaces rely on a balance between physical and digital representations.
- Digital representations are needed to mediate dynamic information.
- The elements of TUIs are spatially re-configurable (in contrast to tangible digital appliances) (Ishii, H., and Ullmer, B, 1997).

Whereas Ullmer's characterisation focuses on issues of representation and its computational coupling, Brauer's perspective is one of human-computer interaction, comparing GUI interaction with graspable interfaces. Brauer defines as special qualities of graspable interfaces the following two key characteristics:

> a) Physical spatiality describes the co-presence of user, objects and other users in one interaction space. This space is a hybrid. Physical objects have a double affiliation to real/physical and virtual/digital space, but must still obey laws of the physical world. Real and virtual parts are each enhanced by the other. Because of co-presence of users and objects, interaction takes place IN the user interface. Therefore input and output space coincide. The user experiences a bodily shared space, his/her body is in the same space as the interaction objects. Following [17, 22, 35, 41] physical spatiality, by preserving physical laws and sharing of space, results in well-understood visibility of objects and of gestures. Strictly speaking this characteristic is a prerequisite for the next characteristic.
>
> b) Haptic directness denotes direct manipulation where the physical, graspable objects themselves are the interface. The user has direct contact with the interface elements and has an embodied experience of manipulation, using his/her hands and body movements. Interaction is unmediated and intuitive, leading to 'direct engagement'. Because hands interact directly with interface elements, two-handed or parallel interaction is possible. Unmediated, direct manipulation results in isomorphic and structure-preserving operations.

The motivation for the TMG is that our ancestors developed in the past a range of specialized physical arifacts with different functionality, for instance to measure the passage of time, to predict the movement of planets or to compute. By grasping and manipulating these instruments, they developed rich languages to interact with real physical objects.

> "Newly arrived and quite ignorant of the languages of the Levant, Marco Polo could express himself only by drawing objects from his baggage-drums, salt fish, necklaces of wart hogs' teeth-and pointing to them with gestures, leaps, cries of wonder or of horror, imitating the bay of a jackal, the hoot of the owl…"
> (Italo Calvino, Invisible Cities)

But many of these artifacts disappeared and were replaced by the most common of devices: the Personal Computer (PC). In consequence, the Human Computer Interaction is nowadays limited to the use of a screen (desk-mounted, head-mounted, hand-held, etc.), a mouse and a keyboard. The Tangible Media Group wants to reject this traditional way of HCI and wants to use real physical objects for representation and control of digital information instead.

Up to now, most research on tangible interfaces has focused on implementation. This concentrates on defining concepts, building category systems (B. Ullmer and H. Ishii, 2000), evaluating usability (M. Fjeld,*et al*, 1999) or potential interaction metaphors. The focus is on single user interaction, with questions of cooperative use largely left out of consideration. As requirements for cooperative use are not identical with usability requirements for single user settings a deeper understanding seems essential in order to deliberately design for cooperative use. Cooperative use is an essential part of this project but like others my focus has been on the form of the object, simplicity of the interactions, and the media being interacted with. It is more art than science. This is something I haven't addressed in this project as of yet but will address in the future.

Music and sound applications for tangible interfaces have become very popular. It is interesting to note the reliance tangible musical interfaces have on table-top controllers or "music tables" metaphors. This is not always the case as we will see in much of the work done at MIT where other metaphors are introduced. The following is an introduction to some of the related work done prior to this project.

2.4 Related Work

Audiopad

Developed by James Patten and Ben Recht Audiopad "is a composition and performance instrument for electronic music which tracks the positions of objects on a tabletop surface and converts their motion into music. One can pull sounds from a giant set of samples, juxtapose archived recordings against warm synthetic melodies, cut between drum loops to create new beats, and apply digital processing all at the same time on the same table.

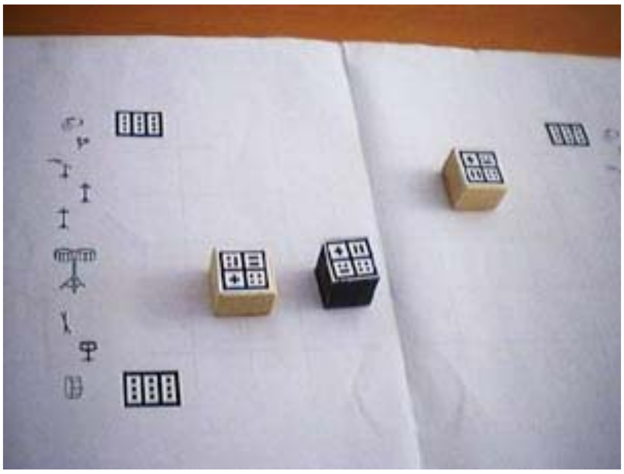
Audiopad not only allows for spontaneous reinterpretation of musical compositions, but also creates a visual and tactile dialogue between itself, the performer, and the audience.

Audiopad has a matrix of antenna elements which track the positions of electronically tagged objects on a tabletop surface. Software translates the position information into music and graphical feedback on the tabletop. Each object represents either a musical track or a microphone."

Using audiopad offers advantages to say a simple LCD touch screen - though Lemur does come close. Lemur is a handy and modular touchpanel based controller designed for audio and multimedia real-time applications. Tabletop interfaces provide ample room to organize objects spatially, which can be an important part of thinking about the problem solving process. Finally, physical objects in this type of environment can be more than just input devices: they can become embodiments of digital information (James Patten, 2002).

Audio d-touch

E. Costanza's audio d-touch is a set of 3 applications for music composition and performance: the Augmented Stave, the Tangible Drum Machine and the Physical Sequencer. It uses a consumer-grade web camera and customizable block objects to provide an interactive tangible interface for a variety of time based musical tasks such as sequencing, drum editing and collaborative composition. d-touch is a framework for the development of tangible user interfaces based on computer vision.



I like his approach for its simplicity and the use of ready-made tools repurposed for new uses. His argument is that other tangible projects "use of expensive and sometimes fragile technology – such as sensors and displays – embedded in the tangible interactors, mitigates against their widespread use."

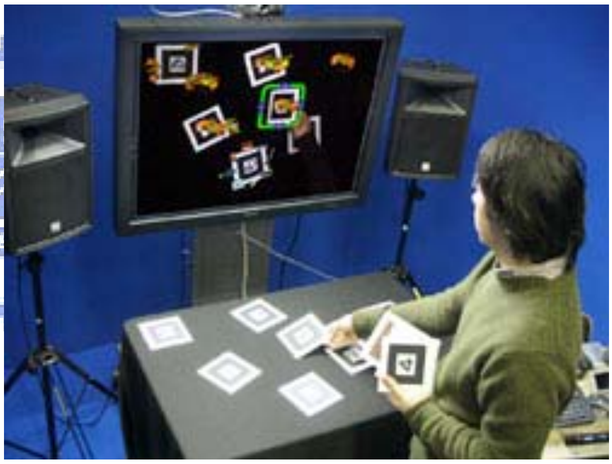
 "In audio d-touch the user can create patterns and beats, rather than adjusting preset ones. In general we use direct mapping of physical quantities to musical parameters (such as timbre and frequency), resulting in simpler interaction. This simplicity, however, does not prevent the interface from being very flexible and allows advanced users to research and create rich and complex sound textures. We stress the use of analogy both in terms of similarity to traditional music notation and in terms of high definition (virtually continuous) mapping between input and output.

The system tracks the position of interactive objects with a web-cam, by means of a robust image fiducial recognition algorithm. In order to make an object recognisable and interactive, it has to be marked with the fiducial pattern. Technical details can be found in]. This technology is significantly less expensive to that required for comparable systems. As a consequence our instruments are targeted at musicians and museums as well as home users and schools (Costanza, 2003).

Music Table

The Music Table, by Rodney Berry, Mao Makino, Naoto Hikawa, Masumi Suzuki, is an experimental composing system that provides a tactile and visual representation of music that can be easily manipulated to make new musical patterns. It lets people experience their own music as patterns in musical space. Patterns of cards are arranged on a tabletop to become musical phrases. Completed phrases are stored on other cards and combined as multi-layered patterns. Animated characters provide fun visual feedback as you edit and arrange phrases, making abstract musical structures visible and tangible.

This physical/tactile representation reinforces the visual contour of the melody through large muscle actions of the arms and body as the user places and moves the cards on the table. It is our belief that this physical connection will help to guide the early development of musical abstraction in younger users (Berry et al, 2003)".



The project's future aims are very in line with mine: "The live sequencing of music offers some of the immediacy of live performance without the frustration of a conventional instrument. The Music Table currently sits somewhere between the world of children and the world of adults and will most probably be split into two separate projects to better meet the needs of each. For children, we would like to develop the character aspect of the representation to make learning more fun. For the more advanced composer, it should be possible to build larger structures and save them for later editing."

This project also makes use of camera positioning as a means of tracking the position of the graspable objects on a table. "A camera placed above the table recognizes special patterns on the cards. By determining the position and rotation of each card on the table, the computer can interpret these positions as musical events. A MIDI sequencer sends this information to a synthesizer to produce the music. … the software can also superimpose computer-generated images into the real scene according to the positions of the markers " (Berry et al, 2003).

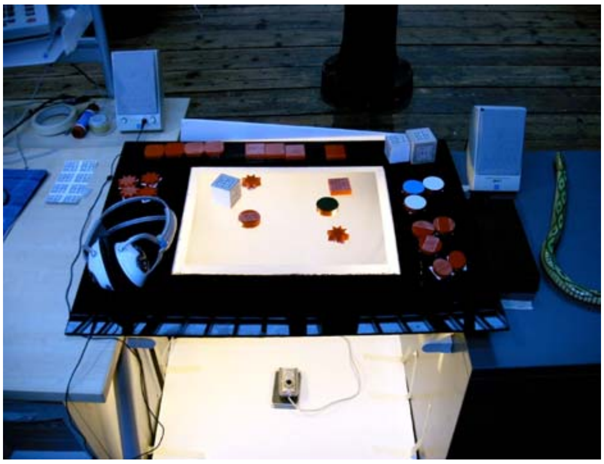
Jam-o-drum

Tina Blaine's Jam-o-drum integrates velocity sensitive input devices and computer graphics imagery into a tabletop surface, allowing six to twelve simultaneous players to participate in a collaborative approach to musical improvisation. The Jam-O-Drum was designed to support face-to-face audio and visual collaboration by playing on drum pads embedded in the surface to create rhythmical music and effect visual changes together using the community drum circle as a metaphor to guide the form and content of the interaction design. The Jam-O-Drum is a permanent exhibit in the heart of Sound Lab at the Experience Music Project.

Using very simple controls allows for an almost complete removal of barrier to entry concerns. "By creating an interface with a very simple control gesture — hitting a flat surface — we sought to create an experience which would engage people with a wide range of capabilities. Although most of the sound design was built using percussive sounds by integrating melodic long tones in more ambient compositions we hoped to provide a role for those undisposed or unable to engage in vigorous percussive playing" (Blaine, Perkis, 2000).

reacTable

Sergi Jorda's reacTable* is an electronic music instrument with a tangible table-based interface, which is currently under development at the Audiovisual Institute at the Universitat Pompeu Fabra, that allows expressive collaborative live performances for professional musicians without the limits of many screen-based interfaces for electronic music. As its name suggests the reacTable* is another table-based instrument; it can be played by manipulating a set of objects that are distributed on top of the table surface. Each of these objects has its dedicated function for the generation, modification or control of sound. Bringing these objects into proximity with each other constructs and plays the instrument at the same time. While the table is equipped with sensors for the identification and tracking of the objects, the players themselves do not (and must not) have to wear any controller devices. In addition to the sound which is obviously produced while playing, the reacTable* also provides additional visual feedback by projecting a visualisation of the sound-flow onto the table surface.



One of the more relevant aspects of this instrument is that it is intentionally designed to be playable by more than one person at a time. These collaborative aspects will be taken even further by networking two or more instruments allowing remote collaboration. In the creation of the Adult Chairs installation I was influenced by his modular design of reacTable* which led me to choosing the solution that I have. He describes the system as being "implemented in a completely modular way, allowing the easy reuse or replacement of the four basic functional components: a sensor module is tracking the state, position and orientation of any object that is currently present on the table. These raw sensor parameters are passed to the central management component, which drives the two actual synthesis components for the sonic and graphical feedback. All these components are completely independent and are communicating via a simple proprietary network protocol. This separation allows the execution on various different hardware platforms avoiding eventual performance bottlenecks since each of these modules actually requires quite a lot of computational resources" (Kaltenbrunner, Geiger, Jordà, 2004).

Instant city

I found Instant City too late to have a direct effect on the ideation of the installations but their thoughts on creating this type of installation are in line with my own, For us the challenge of this interactive installation lies in enticing the audience into action, not only in front of the monitor or with a keyboard, but also in relation to physically real, sensually graspable objects. This action, on the other hand, should influence the atmosphere of the total space luring
other people to play and listen… "

Instant City can be described as a music building game table. One or more players at a table can create architecture using semi-transparent building blocks and in the process make different modular compositions audible. Every performance is unique because the sequence, timing and combination possibilities are completely in the hands of the players! For each game one composition is chosen. To date, eight different musicians have each produced special compositions which serve as the basic music building kits of instant city. The repertoire and compositions can and will be continually renewed/replenished" (Hauert and Reichmuth, 2003).

Audiocube

From the company Audite comes AudioCube. Audite focuses on the conception, design and implementation of innovative audio installations and develops individual acoustic techniques and systems for fields such as Virtual- and Augmented Reality, Entertainment, and Edutainment.

AudioCube is an installation that allows a group of users to create their own three-dimensional soundscape. Four cubes are placed on a glass plate. Each side of the cubes refers to a different sound, each cube refers to a category of sounds: drums, base, leads and strings. These cubes can then be turned to change the associated sound. The position of the cube on the glass plate refers to the position of the sound in the room. Due to this combination the users can create an individual soundscape within 3D-space. AudioCube is currently shown as a connection between the exhibitions musical instruments and medien.welten at the technical museum vienna.

Scanjam

Scanjam is a music performance system consisting of two scanners and a computer. It takes advantage of the time-based nature of the scan head and maps each scanner to one bar of music. The music is composed in two bar "modules". Objects placed on the scanner are read and depending on their color, shape, and vertical placement, trigger sounds when the scan head passes them by. When one scanner reaches its end the next scanner begins. While the second scanner is scanning, the first scanner is "rewinding". This project is a concept study only, it doesn't seem to be implemented yet.

Block jam

From the abstract, “Block Jam is a Tangible User Interface that controls a dynamic polyrhythmic sequencer using 26 physical artifacts. These physical artifacts, that we call blocks, are a new type of input device for manipulating an interactive music system. The blocks' functional and topological statuses are tightly coupled to an ad hoc sequencer, interpreting the user's arrangement of the blocks as meaningful musical phrases and structures. We demonstrate that we have created both a tangible and visual language that enables both the novice and musically trained users by taking advantage of both their explorative and intuitive abilities. The tangible nature of the blocks and the intuitive interface promotes face-to-face collaboration and social interaction within a single system. The principle of collaboration is further extended by linking two Block Jam systems together to create a network."

Block jam is certainly an impressive piece of work, I am particularly enamoured by their belief "in a future where music will no longer be considered a linear composition, but a dynamic structure, and musical composition will extend to interaction." They believe that the distinctions between composer, performer, and listener will be blurred due to technology. Let's hope that that is true, that technology can have that kind of positive effect.

Their second goal is very much in line with mine, "Our second aim is to put the group experience back into music. We understand that the musical experience changes with technology. Musical technology provides greater control, more possibilities and greater access to the beginner or novice (Newton-Dunn et al, pg. 2, 2003)."

An interesting contradiction they raise is that despite the great community enabling effect technology can have, the experience of listening to music is becoming more personal. "Degrees of separation have occurred between the composer and the performer, the performer and the audience. This trend continues. Block Jam is the first in a number of projects aimed at addressing this disparity within the technologically mediated musical experience" (Newton-Dunn et al, pg. 1, 2003).

They divided their work into two parts, one part designing the interface the other designing the musical experience. While their thoughts regarding designing musical experiences are not directly related to this chapter they are well worth recording here.

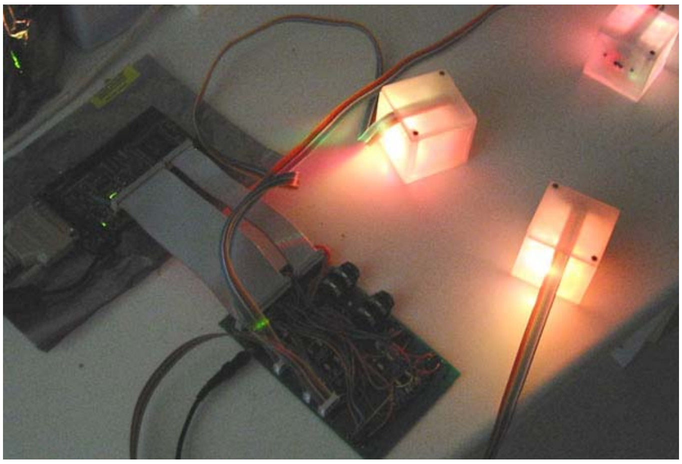
"We can think of music as a communicative conduit, as a performance, and as a mono-directional expression. We prefer to consider music as bi-directional (or even omni directional) since music is about teamwork and group interaction. It is a promoter of communication, excitation, and mediation, and most importantly to us, creative interplay. This notion can be identified in the compositions of artists such as Arnold

Schoenberg, Karlheinz Stockhausen and notably John Cage" (Newton-Dunn et al, pg. 2, 2003).

Their thoughts on designing the tangible interface were something that I discovered through testing Hullabaloo. Adults just were not engaged in the same manner at all as children were. It was such a crucial distinction that it was suggested to not demo Hullabaloo again in the future without supporting video of children using the device. Their thoughts, "Children's toys tend to be physically organized and actuated, have meaningful use of shape and color, are iconic and often include sound. Children's toys also have immediacy. These were all characteristics we hoped to include and emulate in our design, the major difference being that our target users were adults, who require a much greater sophistication than children in order to be experientially engaged" (Newton-Dunn et al, pg. 2, 2003).

Audio cubes

A new Tangible User Interface, which is to be used by musicians and performers to create sounds and music in real-time and stimulate their creativity through experimentation. The interface consists of a number of programmable cubes, made of a translucent material. By positioning the cubes relative to each other, an optical audio processing network of audio signal processing algorithms can be created. The nature of the interface allows the user to achieve a level of interaction hard to achieve using audio software.



The technical design of Audio cubes takes a slightly different approach. "Each cube contains a digital signal processor (DSP) with optical sensors and emitters (infrared, red, green and blue LEDs). The sensors and emitters receive and send audio signals which are generated or processed by the signal processor in the cube. Each cube is powered by a rechargeable battery pack. By positioning the cubes relative to each other and moving them around, a signal processing network can be created. A musician can use this interface to learn a new way of interacting with sound and music.

On the left you can see the components of an AudioCube. The cube is based on a TMS320LF2407 DSP, which controls 6 RGB LEDs or 18 separate LEDs, as well as 6 infrared LEDs for audio transmission. Infrared phototransistors are used to receive the audio signals. The cube is powered by a battery pack, which can be charged using the charging circuit in the cube. To give the performer even more control over the algorithm running on the DSP, different sensors could be added, such as an orientation sensor, shock sensor, position sensor, etc." (Bert Schiettecatte, 2004).

Augmented groove

Augmented Groove is a musical interface for electronic music and, more specifically, techno dance music. Augmented Groove uses augmented reality, 3D interfaces, and physical, tangible interface technologies to allow performers to conduct multimedia musical performances. The performer modulates and mixes compositions by manipulating real LP records. The motions of the records control filters, effects and samples dynamically mixed in and out of the groove. A composer can assign any element of composition to any record and the song progression is controlled simply by removing one record and bringing in another. Effects, filters and sample triggering are all assigned to any of the four record movements (figure below) and can be controlled interactively using simple physical records rather than numerous dials and sliders (Poupyrev et al., 2000).

Squeezables

One of the final concepts that I had decided on for a more advanced tangible interface was a ball. Though I knew balls were used in a number of examples including the Music Shapers (Weinberg, G, 2000) I set to investigate a wide range including foam balls, rubber balls, fabrics, and even stretchable media like Play-Doh. I thought and still think that the this shape is an ideal one for music play if for only the reason that balls are so approachable,

squeezable, and very tactile. I had settled on a group of pressure sensors and a basic technical design approach. As luck would have it Gil Weinberg and Seum-Lim Gan had already created squeezables using much the same technical design ideas.

From "The Squeezables: Toward an Expressive and Interdependent Multi-player Musical Instrument": "The Squeezables is a computer music instrument that allows a group of players to perform and improvise musical compositions by using a set of squeezing and pulling gestures. The instrument, comprised of six squeezable and retractable gel balls mounted on a small podium, addresses a number of hardware and software challenges in electronic music interface design. It is designed to provide an alternative to asynchronous and discursive interactions with discrete musical controllers by allowing multiple channels of high-level simultaneous input. The instrument also addresses new challenges in interconnected group playing by providing an infrastructure for the development of interdependent, yet coherent, multi-player interactions. As a test case for a particular high level control and interdependent mapping scheme, a short musical composition was written for the instrument and was performed by three players" (Weinberg, 2003).

Sonic banana

The Sonic Banana is a MIDI controller and alternative musical instrument in the form of a 2 foot long flexible rubber tube. Four bend sensors, each 5" long, are mounted in a row along the inside of the tube on a flexible metal bar running the length of the tube. A single pushbutton switch is mounted at the top end of the tube.

The pushbutton and sensors connect to a microcontroller which converts data from these inputs into MIDI messages. Bending the tube in different locations changes the control value corresponding to the sensor in that location. The pushbutton switch sends a MIDI note-on with pitch 60 and velocity 127 when depressed and 0 when released. Data from the Sonic Banana can be sent into Cycling 74 Max and processed to create a variety of algorithmic improvisational instruments.

Music bottles

Music bottles is a tangible interface that utilizes bottles as containers and controls for music. The system consists of a specially designed table and three corked bottles that metaphorically contain the sounds of the violin, the cello and the piano in Edouard Lalo's Piano Trio in C Minor, Op. 7. When a bottle is placed onto the stage area of the table and the cork is removed, the corresponding instrument becomes audible. The interface allows users to structure the experience of the musical composition by physically manipulating the different sound tracks.

When we add new digital meanings and functionality to inert physical objects, we need to maintain coherency of the conceptual model in both the physical and digital worlds. This requires seamlessly extending the metaphor and built in physical affordances of objects to the digital domain. However, unlike a graphical user interface, which is well constrained by a program, the manipulation of objects in the physical world is much less constrained. As a result, when designing our interface it was necessary to identify a fundamental set of interactions that were both appropriate to the task and also compatible with the available sensor technology.

3 The Exhibition

Quiet Please! was described as an exhibition of Sound Art and Interactive Design which attempted to change our perception of how we view and interact with music and sound.

Sound art challenges fundamental divisions between visual art and music. Works of sound art play on the fringes of our often-unconscious aural experience of a world dominated by the visual. This work addresses our ears in surprising ways: it is not strictly music, or noise, or speech, or any sound found in nature, but often includes, combines, and transforms elements of all of these. Sound art sculpts sound in space and time, reacts to environments and reshapes them, and frames ambient "found" sound, altering our concepts of space, time, music, and noise.

Tangible interfaces allow us to realize seamless interfaces between humans, digital information, and the physical environment by giving physical form to digital information and computation, making bits directly manipulable and perceptible.

The exhibition offered an opportunity to showcase the latest interations of the prototypes of the ideas I explored during the course of this project. The following is the majority of outcomes of this work.

3.1 Hullabaloo

Hullabaloo was originally called child chairs and represents one of my first attempts at creating a tangible music interface. Child Chairs are simple tangible interfaces that allow children to participate in a music game that tests and increases their musical and memory acuity. Child chairs, renamed Hullabaloo, are prototypes for a new concept called Networked Smart Musical Toys.

3.1.1 Overview and background

Hullabaloo represents my second attempt at creating a tangible music interface and was designed and conceived at approximately the same time as the Adult Chairs installation. The name Hullabaloo means great noise or excitement and seemed like an appropriate term to describe the device I set out to create.

My first implementation of hullabaloo involved embedding a simple switch into the seat of a wooden chair. This was to allow children to have the ability to control a voice from simple melodies in an overall composition. I hadn't actually thought of using pillows with the chairs at first, thinking that perhaps the pillows and chairs could be two separate devices. It worked well but to engage children in a more inviting way I thought an addition or change to this form was needed. As well, since the interaction was to be quite simple, I wanted to create a musical game around the chairs and make this interface as portable as possible. With that in mind I explored additional objects to add to the chairs and eventually I converged on the design of the installation using both the pillows and chairs at the same time. Pillows are an extremely common object in many people's environment and allow for a great deal of aesthetic expression. They are approachable and may either elicit a sense of play or comfort.

As I mentioned in chapter 2 Hiroshi Ishii's Music Bottles were a great early influence on much of this work. In his paper "Bottles as a Minimal Interface to Access Digital Information" with Ali Mazalek and Jay Lee, he writes about the need to "explore the transparency of an interface that weaves itself into the fabric of everyday life", a statement which fits very well with my overall goals. In selecting pillows as an interface, and this applies to all the interfaces I created, there are some important considerations. First, when we add new digital meanings and functionality to inert physical objects, we need to maintain coherency of the conceptual model in both the physical and digital worlds. This requires seamlessly extending the metaphor and built-in physical affordances of objects to the digital domain (Ishii., 2000). Secondly, when designing the pillows interface it was necessary to identify a fundamental set of interactions that were both appropriate to the task and also compatible with the available sensor technology (Ishii, 2000).

The basic affordance of pillows is to provide support and comfort. In addition to this there are some basic interactions such as squeezing and throwing. Unlike with the Music Bottles, I was not able to ascertain more sophisticated gestures. As I wanted to make the use of the interface as simple as possible, pillows are ideal in that regard. I didn't want the interface to suffer from a greater complexity and be subject to different interpretation. In order to eliminate the problems that can occur in interpreting the proper use of the interface I opted for a minimal design that would implement only the basic affordance of pillows. This resulted in fixing the pillows with a chair and not as an independent object. Thus the basic affordance is one of comfort.

3.1.2 The Game

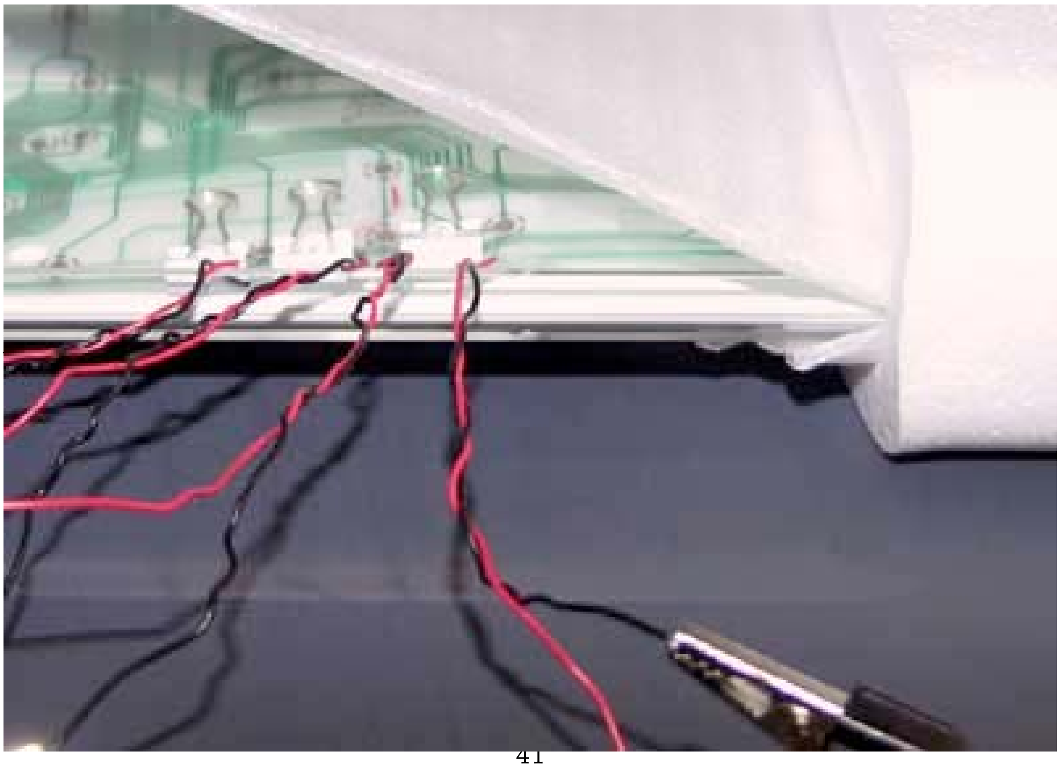
The inspiration to the design of the game for Hullabaloo was university music listening classes. It was common practice to walk into class and have a professor put a LP on the player, simply drop the needle anywhere, and then require you to identify the piece of music and the location within that work. My game is naturally much less intimidating than that and primarily designed to test children's listening and memory skills. A desired secondary effect is the introduction of various pieces of music in general.

The game is very much a group activity and may require some initial coaching. I consider it wise to use this game as part of an over all classroom lesson which includes a song from Hullabaloo's song library or a piece of music very similar to what can be found there. The game scenario is as follows:

1. Using the hullabaloo software GUI, the coach or teacher chooses a piece of music of a varying level of difficulty then plays the song in its entirety. The song can be then played again or it can be decided to continue on to the challenge.
2. Upon deciding to move on, the software then randomly divides the song into four pieces and each piece is assigned to one chair.
3. With help from the class, the child is then required to sit on the chairs to hear which piece of music has been assigned to which chair and try to put them in the proper order. The child is rewarded with a success signal if they get the correct piece and a error signal if they are wrong. They are then required to remember the order of the chairs to sit in them in succession in order to play the song in the proper order.

Initial Design

The initial design for Hullabaloo called for 4 chairs with matching pillows. The pillows themselves were fixed by fabric to the chairs so as to ensure that they stayed in place. Activating the interface is fairly simple, the user must simply sit on the chair, an action which activates a switch. The switch itself was hidden inside each pillow, one switch per pillow. Upon activation the chairs communicate with a flash based client running on an old iMac and produces sound through a basic set of speakers. The switch itself was fashioned with standard off the shelf hardware and used reproposed keyboard to form



ideal for creating an interface for children. I wanted the children to be sufficiently engaged and interested in the installation but the focus should be on the game and the music, not the interface.

One of the most frequent comments about this initial prototype was the lack of any kind visual reinforcement in the interface. For example, when a child sits on the chair a light could change colour, and a correct answer produces a green light while an incorrect answer a red light. This particular idea is entirely valid but I wanted to keep the use of visual signals and cues to the design of the interface only. I wanted the installation aesthetic to draw the children into the game and give them the impression that it was going to be a fun activity. But all signals as to indicate that you are interacting with Hullabaloo I wanted to be audio only. I wanted to see if it is possible for children to enjoy interacting with a device such as this with only audio reinforcement. In a world dominated by the visual I wanted have children focus with their ears.

Another frequent criticism was the selection of music. As this was an early prototype I didn’t take the time to arrange and mix more than two pieces of music. From this criticism came a suggestion which was to be incorporated into the next version. It was suggested that I include the ability to select different skill levels and corresponding pieces of music. As I had planned on creating a large library of music anyway, it seemed that creating an easy, medium, and hard categorization would be a worthwhile addition to the software client.

Hullaballoo was informally tested at Hsinchu International School. The results were promising enough to create a proposal to allow for a more advanced prototype. The proposal follows.

3.1.3 Proposal

Networked Smart Musical Toys

Networked Smart Musical Toys is a direct descendent of the prototype child chairs. The goal of this project is to allow children of a wide range of ages to interact, make, share, and learn with music without the barriers presented with traditional music making instruments. We want to immerse children to as wide a range of sounds and music making opportunities as soon and as quickly as possible. Traditional musical instruments require students to learn interfaces based on the instrument's method of producing sound. It's a difficult and generally time consuming process which delays the musical experience. With digital music such constraints need not be as apparent, so we can introduce more immediate and natural means of expression. Whether they use their feet, wave their arms, roll a ball, or shake a shaker, this project allows children to experience creating music and sound with the means they are most familiar with.

Generally a parent or teacher might slowly introduce sounds, rhythm, musicality, etc of increasing complexity and variety over the course of a child's physical and mental development. You might start with your voice and hands. Later you would introduce small percussion instruments. As a child gets older she/he would be introduced to melodic instruments and the discipline of learning to make sound with these instruments. Children are naturally curious about sound and are intensely creative. Networked Smart Musical Toys can provide the opportunity to experience an endless range of sound, provide new means of expression, and allow family members across great distances to be a part of these events.

Lastly, why can't we share these musical performances, these real time compositions, with family and friends effortlessly over the Internet.

What it is

This toy consists of a set top box and large number of independent wireless tangible musical devices. The set-top box connects to a TV, stereo, and the Internet. Internet access is provided by a wireless connection to an existing WLAN. The set top box runs software that allows access and interaction between a library of music and sound and a large number of connected tangible devices. These devices come in a variety of forms: simple tap pads, balls that you can roll and shake, and wands are a few examples. All of these devices have the ability to connect wirelessly with the host (the set top box). The set-top box connects to the internet to allow for further sound and music download and for the ability to share the results with family.

How it works

Designed to keep all interaction as simple as possible, the system and devices are wireless and require no set-up. A very simple screen based menu allows for optional configuration and is controlled by a simple remote. The musical toys themselves require no instruction and are ready to be used as soon as they are turned on. Current prototypes use Bluetooth to connect all the devices to the set-top box and a 802.11b wireless card to connect to a WLAN.

Value/Potential

A device and service that allows children to experience music in a natural immediate way without the limitations inherent with traditional musical instruments and with the ability to share the results via the internet, this system should prove to be a viable technology prototype if not product.

3.1.4 The Installation

The following are photos of the installation as it was shown during the exhibition.

3.2 Adult Chairs

Adult Chairs is a tangible interface that allows for rudimentary control over a musical performance. The interface, woven into an object that is part of the fabric of our everyday life, adds to the element of surprise helping to create an engaging experience from something very simple.

Adult Chairs is our first prototype. In line with our overall project aims, the concept of Adult Chairs is to embed sensors in everyday ordinary objects allowing people to interact with music and sound with a form that has a completely different use. It is hoped that by making the interface invisible and a part of ordinary objects we can invoke a sense of wonder, surprise, and hopefully engage people in the creation of sound and music in a whole new way.

In Adult Chairs we embed a series of pressure sensors in four tastefully designed matching pillows and chairs. Each pillow has 2 sensors that allow for the control of a number of different parameters in a pre-created music composition. These parameters include: the fade in and fade out of a music track or voice, a subtle control over pitch, change in timbre, and a change in the sound of the voice. The interface is simply activated by sitting on the chairs or pressing on the pillows. Subtle changes in the volume of each music track are affected by the amount of pressure applied to the sensor – if a participant is particularly light this may produce a sound of lower volume. If a participant is heavy the converse would be true. The parameter changes in the individual music tracks is controlled by a subtle rocking movement of the body – this again produces subtle variations from person to person.

3.2.1 Technical

Pressure sensors were supplied by Infusion Systems and were controlled via I-CubeX. I-CubeX is designed to enable you to use sensors for controlling multimedia content. It can also be used to obtain sensor data for (scientific) analysis. With the I-CubeX, translate sensor signals with high resolution into MIDI messages. Then, send these messages to data analysis/display software or, since the encoding is MIDI, to a variety of 3rd party hardware or software devices that perform sound synthesis, graphical animation, video effects, etc..

During the course of the development of the Adult Chairs I wrote numerous sound samples and works of music to be controlled by the system.

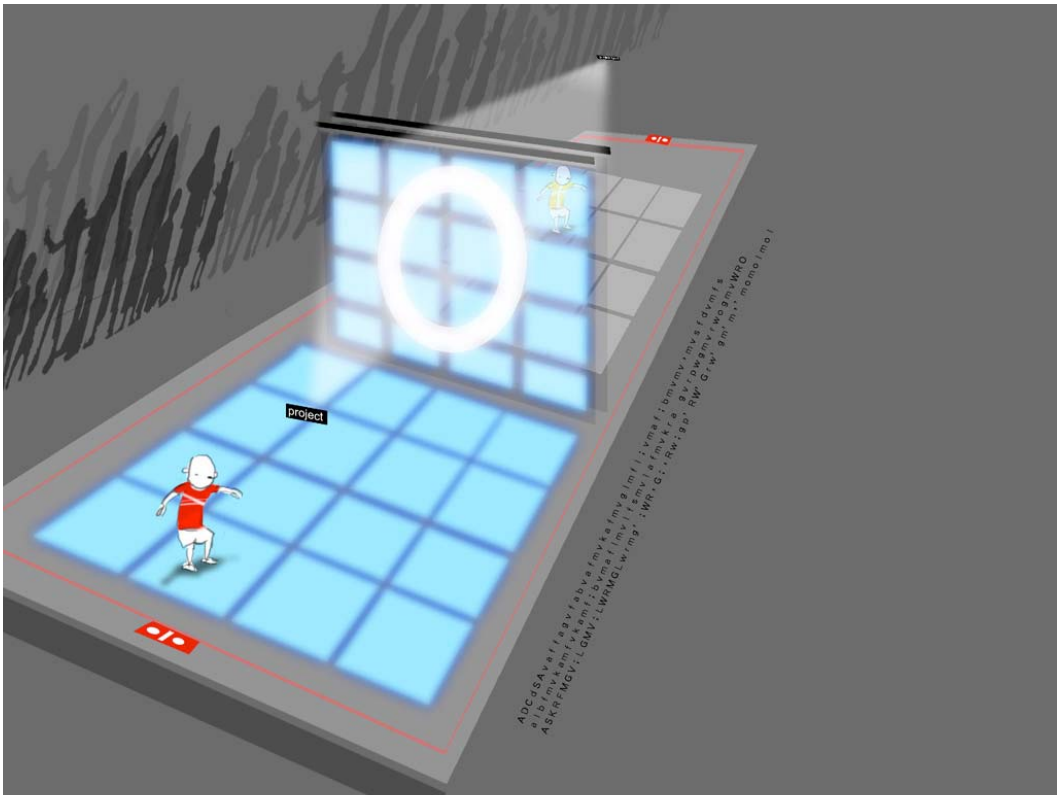
3.2.2 The Installation

During testing it was found that people got the greatest engagement from pre-created music that they could control certain elemental parameters. These included tempo, volume, and pitch. The following are some photos of Adult Chairs as installed at the exhibition. The sound samples and video can be viewed on the projects website.


Adult Chairs
成人音樂椅

3.3 Musical Squares

This is a simple collaborative system for playing musical games against computer, local, and remote participants. It consists of a "software that forms linear sound sequences" controlled by a simple on-screen interface and a tangible interface. The sound is created by stepping on a series of 16 large pads. Each pad has a light display inside and is clickable much like a large button. All the pads are connected together by a wireless sensor which transmits data back to a PC. There are also a series of 7 pads elevated to waist height which allow for control over the selection of games. Visible feedback is provided by both the pads and a projected display. Auditory feedback is provided by a series of speakers. Musical squares is designed for children but should appeal to participants of all ages.



The Games

Call and response

A series of sounds are played with increasing difficulty and the participant is required to play back the sounds in the correct sequence in order to be successful. The sound sequences are supported by visual feedback both on the squares and on the screen. These series of sounds could be melodic or not depending on the participant who inputs the melody. The computer version produces melodies that should be familiar to most. Playing the game is a test of memory, pitch recognition, and basic musicianship.

Variations: player against player, player against computer, player against remote player (via internet).

The remote player utilises a graphical user interface.

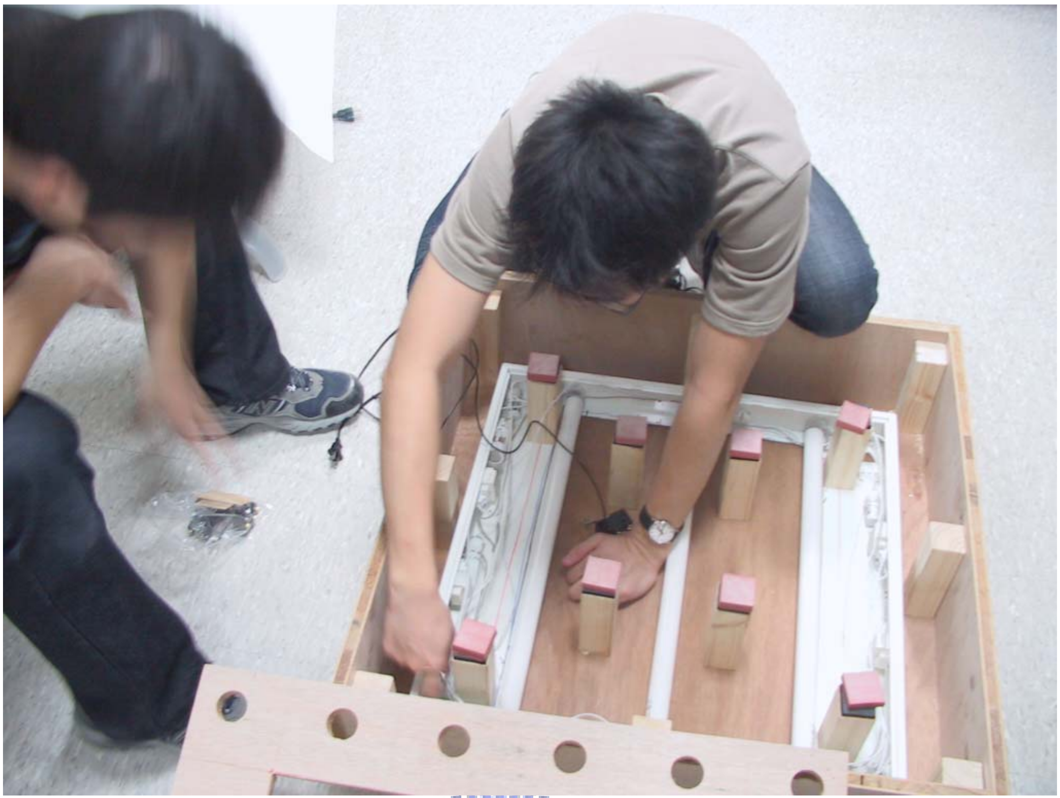
Composition

Participants can interact with the musical squares creating their own musical compositions that can be played back and shared with others. Various games can stem from this as well. Since interacting with the squares is a physical activity people may be inclined to extend their melodies as much as possible.

Interacting with Musical Squares.

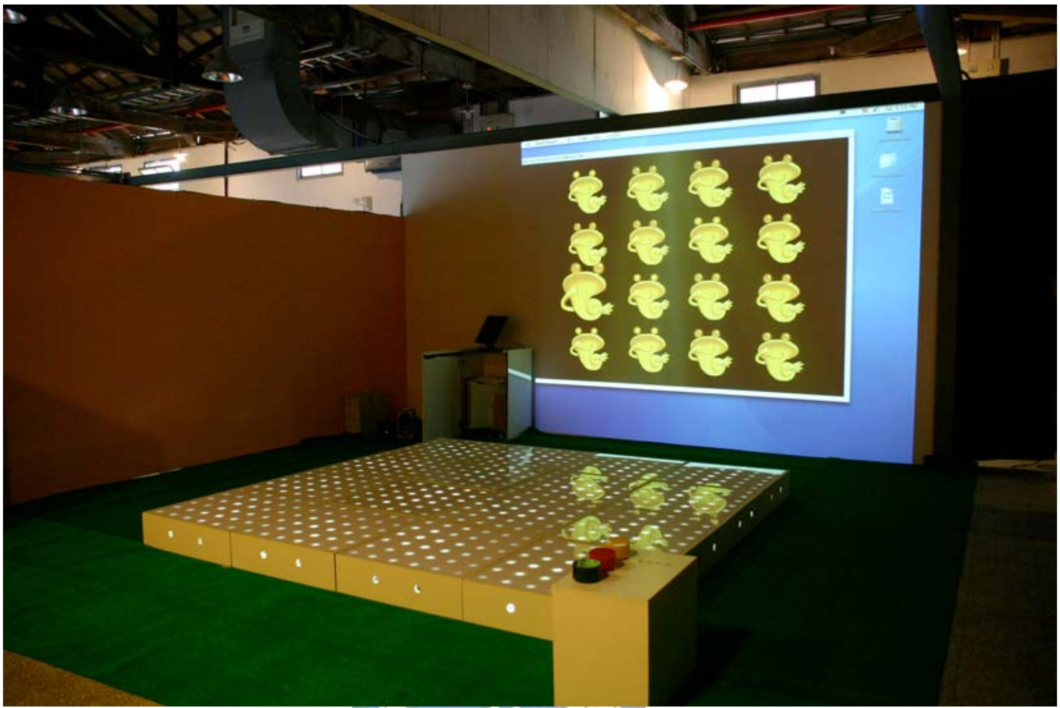
All the pads consist of:

- A switch mechanism inside the pad so that the participant can trigger the sounds.
- A switch mechanism inside the pad that triggers a visual response.
- Visual feedback in the form of coloured light when the switch is pressed.
- Visual feedback for playing the sound sequence.
- Light that provides automated visual feedback when in wait mode.



3.3.1 The Installation

The following are some photos of Musical Squares as installed at the exhibition.



3.4 Girls’ Ambient Room

“With Ambient the physical environment becomes an interface to digital information rendered as subtle changes in form, movement, sound, color or light.

Current information interfaces are either interruptive or too detailed. For the first time in history, ubiquitous wireless networks can affordably deliver digital information anytime, anywhere. The result for most of us is cacophony. Ambient wants to make the world calmer” (Ambient Devices).

Communication via the Internet has become increasingly pervasive. We use MSN and Yahoo messenger, email, web based bbs’s, and comments on our weblogs as means of keeping and forming relationships. Friendster, buddy lists, foaf, and our online address books record our circle of friends. All of these tools help us shape both our online and offline personas. Though our internet self in essence has become less and less disassociated with our ‘real’ self, the tools themselves remain a virtual construct and are kept at a distance. Tracking the data associated with these tools is important to people, but they typically wish to maintain only a peripheral awareness of it. Unfortunately current methods for maintaining awareness are too intrusive via a multitude of on screen applications or the out of tune audio alerts.

Our solution is to bring the information into the environment more completely, allowing a person’s online persona to shape the environment around them.

3.4.1 Overview and background

The girls’ ambient room uses sound, music, animation and light projections to communicate information at the periphery of human perception. It was designed to employ both the foreground and the background of the user’s attention. In normal day-to-day interactions we get information in a couple ways; first we get information from what we are focusing on, where our center of attention is directed. When we are driving down the road, obviously the center of our attention is in front of us. When we are speaking or talking to somebody we are constantly focusing on that person and receiving the information. But while we are driving down the road and while we are talking to someone we are also getting information from other sources, from ambient sources. When we are driving we may have a sense of whether it's windy or not by the sound of the wind or the visual information from the blowing of leaves. When talking to a friend we may get an idea of what other people are doing, whether they are busy, or they're laughing, whether their situation is serious or not by this ambient sound from the presence of other people in the room.

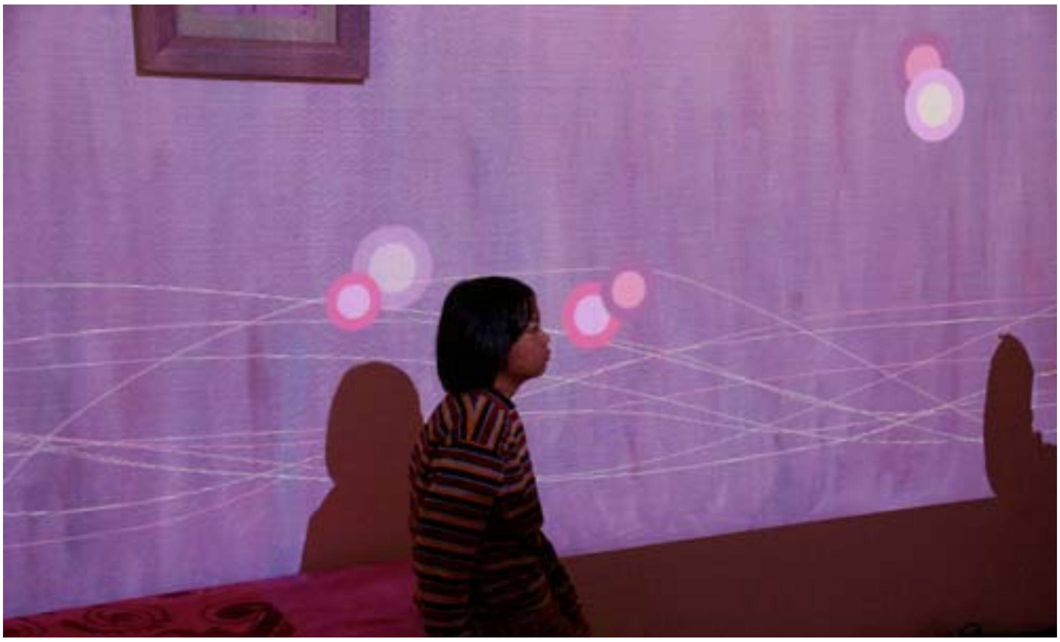
One of the original goals of the girls' ambient room fits very much in line with the work I have been doing with Traffic 2 and 3 (see below) and that is trying to communicate a different idea, a different type of information to deliver a concept to people that the environment in which we live or work relies a great deal upon software and network connectivity and that the network itself is alive, and growing, and changing all the time. The software and the network is entirely silent and we as users of these tools and systems are totally unaware of the magnitude of what is going on in the background, of how these systems are constantly changing and working. So my first goal was to bring software and the network alive and make it part of the user's environment. I wanted to give life to this silent form and in the final iteration of the installation this concept came closest to being realized.

Now the second focus of the girls' ambient room is to subtly and artfully and I might say elegantly display communication which is not the user's primary foreground task. I'm concerned about providing a means for the seamless transition of the user's interaction between background and foreground information. Generally when a process that was not a focus of attention catches our interest we are often able to seamlessly integrate that into our activity. To be able to design something like this is a very challenging and interesting opportunity. Not only am I trying to display and communicate this information that's not in the primary foreground task, I want to remove what would normally be foreground task and that is focusing on a computer screen to receive the information displayed. I want to get people to remove their eyes from this window and allow the information to become part of their environment so that they can receive this information in a more seemingly natural way.

Our ambient room had a number of key differences from others' efforts to build this kind of environment. First of all the focus of our room was on Taiwan teenage girls. And so the design of the environment reflects their aesthetic, their taste, and their values. It also reflects the kind of activities that they do in the privacy of their own room, at least in terms of computing. Thus the information that we are recording and displaying at the peripheral are MSN chat, Yahoo chat, email and entries to their own comment systems to their online journals. Essentially we are providing the means to bring their digital persona into their real world environment. The concept goes beyond just changing the audio signals. When the user, the Taiwan teenager, is in her room and receives a message on MSN chat, she gets an audio signal, all the audio signals are in tune with one another, and also an animation is created on the wall an animation which in this case is an abstract … which fades on to the screen and fades out to the right. When she receives an email there are lines on the screen which start to animate and vibrate. The more email the more active that system is the more vigorous the animation. And for Yahoo there are a bubble like animation and sound which registers that kind of information when it is received. When information or comments are entered into her commenting system on her online website or journal there is a change in the visual state of the room. In addition to this I wanted to create a means to register a different data stream, that being the time of day. I created a number of soundtracks which change depending on the time of day, as an example, first thing in the morning the sound track very much reflects a desire to wake up, so the sound reflects energy. There are a lot of bells, tension, and dissonance. And in the evening as a counter example the sounds in the soundtracks are much more subdued, and much more relaxed. All these soundtracks and all these signals and all these visuals are all designed together and in tune together.

3.4.2 Installation

The following are some photos of the Girls Ambient Room as installed at the exhibition.

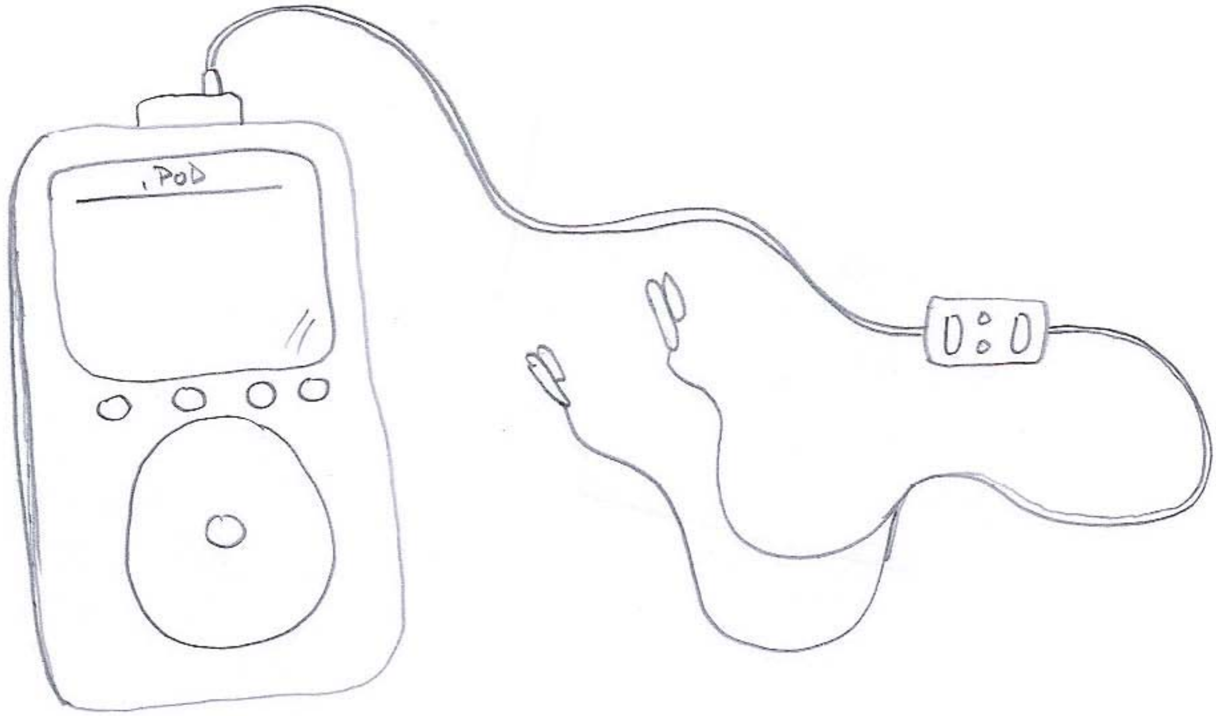


3.5 GuideBot

Guidebot is a wayfinding device that allows you to receive important information at the periphery of your attention. This allows you to focus on the important task at hand, driving, without having to focus on difficult to use visual GPS wayfinding systems. In general ambient devices elegantly embed digital information into the objects and environments that surround us. These displays are in the form of sound, air pressure, motion, light, smell, and other media that complement the full range of our human sensory modalities. They exist in the periphery of our senses, where they provide continuous information without being distracting. I want to bring important digital information into our environment in a non-intrusive way. For Guidebot I have chosen to focus on using our aural sense, an oft forgotten component of our information receiving senses.

3.5.2 Proposal

In visually noisy environments as we often find in Taiwan, way finding systems have a tendency to lose effectiveness. Also, as a space evolves over time the wayfinding system, unless designed with a great deal of foresight, may not be able to adapt. We have been provided with the means for up-to-date wayfinding using electronic map and GPS systems but in these complex visual environments that you see in Taiwan forcing the user of such a system to put their visual focus on anything other than the task at hand can produce problems. An alternative to the time consuming and interruptive nature of the push and pull of visual wayfinding interfaces would be to create a device that functions similarly to a museum's guided tour. Such a device would give you location data aurally, at the periphery of your attention, seamlessly integrating with your environment. A secondary function would be entertainment, playing music, creating the impression of walking/driving through a soundtrack or music video for the area.



What is it

This audio service provides location data in real time as a person walks or travels by car. The data is shaped depending on the mode of travel, providing more location specific data when walking than when driving and turning off music when driving. The audio service provides data from signage, streets, major waypoints, and places of key interest. More specific data could include names of places, entry points to buildings, business names, crosswalk locations, and even changes in weather that might affect travel. The music soundtrack can be predetermined by the person or by the system. The audio information and music is delivered to a device that sits on top of an iPod and is listened to through the accompanying in-ear phones. The device could also be developed as a stand-alone unit, with built in flash memory and digital audio player functions.

How it works

Prior to travel a person would select their travel region and choose from different thematic channels: geographical, historical, music, and practical. The audio information is then downloaded from a server and transferred to the iPod (or self contained unit) on the next sync. GPS provides real-time location information and tracks are played as soon as the person reaches the geographic location corresponding to the x,y coordinates under which the information is filed. People would listen to the audio tracks

on their headphones. They can also listen to the soundtracks independently if they choose and the location data as well – though it is more effective in real time.

Value/Potential

By providing both useful information and entertainment, Guidebot enhances the walking and driving experience. It also introduces an element of learning for people, and helps them to build and retain a memory of places they've passed or visited. Capitalising on the popularity of digital audio players in general and the iPod specifically, the project can bring ITRI expertise to a whole new audience. As well the project if implemented could show market potential within a short period of time.

3.5.3 Technical

As this is only a concept no prototypes have been made as of yet. Numerous devices have been made to extend the functionality of the iPod by connecting to the port on top. These devices send and receive data to the iPod so this concept is quite possible. An interesting aspect of the technical design of this proposed concept is the container of the data itself, the mp3 file. The original specification for the mp3 file itself didn't allow for the saving of information about the contents, except for some simple yes/no parameters like "private", "copyrighted" and "original home" (meaning this is the original file and not a copy). Later an addition to the specification was made so that by adding a small chunk of extra data in the end of the file one could get the MP3 file to carry information about the audio and not just the audio itself. It is this space at the end of the file that would allow for the GPS information to be stored.

A new specification called ID3v3 has been developed that promises to allow for a seemingly unlimited amount of data to be stored with-in the mp3 file (up to 256 meg). From Martin Nilsson:

> "ID3v2 is a new tagging system that lets you put enriching and relevant information about your audio files within them. In more down to earth terms, ID3v2 is a chunk of data prepended to the binary audio data. Each ID3v2 tag holds one or more smaller chunks of information, called frames. These frames can contain any kind of information and data you could think of such as title, album, performer, website, lyrics, equalizer presets, pictures etc. The block scheme to the right is an example of how the layout of a typical ID3v2 tagged audio file may look like.
>
> One of the design goals was that the ID3v2 should be very flexible and expandable. It is very easy to add new functions to the ID3v2 tag, because, just like in HTML, all parsers will ignore any information they don't recognize. Since each frame can be 16MB and the entire tag can be 256MB you'll probably never again be in the same situation as when you tried to write a useful comment in the old ID3 being limited to 30 characters.

Speaking of characters, the ID3v2 supports Unicode so even if you use the Bopomofo character set you'll be able to write in your native language. You can also include in which language you're writing so that one file might contain e.g. the same lyrics but in different languages." (Martin Nilsson, 1998)

3.5.3 Installation

Guidebot was exhibited as a poster.

3.6 Traffic 1

A series of sound vignettes played through custom-built enclosures. Traffic 1 communicates through sound various emotions felt during the daily commute through Hsinchu's streets

3.6.1 The Installation

This installation was primarily audio based and can be experienced on the projects website.

3.7 Traffic 2

An important part of Smenms was gaining an understanding of how the network can play a part in our music making activities. Our exploration led beyond the concept of linking remote participants to how the network itself can become an essential part of the artwork. Traffic 2 and 3 are an expression of this idea.

Traffic 2 attempts to create spontaneous real time auditory compositions or improvisations using data gained from network traffic. A secondary aim is to test our understanding of the usage of network data in the public and private sphere. We treat the network as an unseen life form – a body in constant change – born from the usage patterns of the users of the system. By using network traffic as a tool for creating music we in effect illustrate this unseen form.

Unlike traditional musical performances, Traffic 2 does not exist over a set period of time. It is in effect never ending and never the same at any given point in time.

Traffic 2 uses a very simple logic. Pre-created sound files are dynamically played as their corresponding data id number is recorded by our server software. In the first step, we use Carnivore to collect network data. Using the "sender ip" we call different sounds (or movies). The following is the formula: There are 4 numbers constitute an ip, eg. a.b.c.d, then we transfer it to a unique number using the operation:IPNun=a*16^3+b*16^2+c*16^1+d*16^0 to get an unique number IPNun, then mode it with the number (MovNum) of movies we have, i.e.(IPNun) mod (Movnum). The result is the movie number which we will call in the movies' sequence.

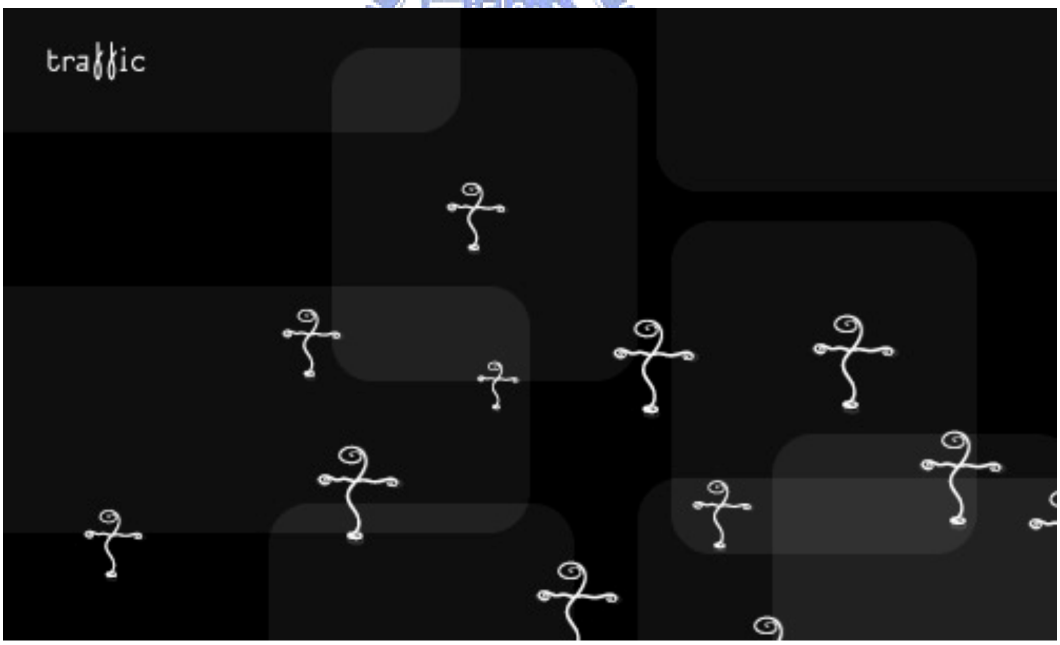
Both Traffic 2 and 3 were based on Carnivore, a surveillance tool for data networks. Our client listens to the Internet traffic (email, web surfing, etc.) on a given local network and is designed to animate, diagnose, or interpret the network traffic in various ways. Carnivore clients have been produced by a number of computational artists and designers from around the world.

CarnivorePE is inspired by DCS1000, a piece of software used by the FBI to perform electronic wiretaps. (Until recently, DCS1000 was known by its nickname "Carnivore.") Improving on the FBI software, CarnivorePE features new functionality including: artist-made diagnostic clients, remote access, full subject targeting, full data targeting, volume buffering, transport protocol filtering, and an open source software license

"Carnivore" taps the data lines of the server on which it is installed. A flow of data is fed into a software client for the purposes of artistic performance.

3.7.1 The Installation

This installation was primarily audio based and can be experienced on the projects website. Below are some visuals from the limited visualizations that were projected in addition to the audio. A iron sculpture that was created as part of the exhibition was dropped at the last minute. Unfortunately no media is available for the sculpture.




Traffic

3.8 Traffic 3

Traffic 3 shares the same logic as traffic 2 but enjoys some key differences.

"Let us cross a great modern capital with our ears more alert than our eyes, and we will get enjoyment from distinguishing the eddying of water, air and gas in metal pipes, the grumbling of noises that breathe and pulse with indisputable animality, the palpitation of valves, the coming and going of pistons, the howl of mechanical saws, the jolting of a tram on its rails, the cracking of whips, the flapping of curtains and flags. We enjoy creating mental orchestrations of the crashing down of metal shop blinds, slamming doors, the hubbub and shuffling of crowds, the variety of din, from stations, railways, iron foundries, spinning wheels, printing works, electric power stations and underground railways."

Luigi Russolo

We were greatly influenced by many of the ideas proposed by futurist artists.
Balilla Pratella wrote in the manifesto, Musica Futurista in 1912 of the futurists desire "To present the musical soul of the masses, of the great factories, of the railways, of the transatlantic liners, of the battleships, of the automobiles and aeroplanes. To add to the great central themes of the musical poem the domain of the machines and the victorious kingdom of Electricity." In his manifesto, Pratella stated "I unfurl to the freedom of air and sun the red flag of Futurism, calling to its flaming symbol such young composers as have hearts to love and fight, minds to conceive, and brows free of cowardice."

Born in Milan in 1885, Luigi Russolo joined Marinetti's Futurist movement in 1911. A painter, not a musician, Russolo was committed to being the movement's musical activist. He replied to Pratella in his own manifesto The Art of Noise of 1913 arguing that the limited range of contemporary musical instruments could no longer satisfy modern man's acoustic hunger. "Let us break out since we cannot much longer restrain our desire to create finally a new musical reality, with a generous distribution of resonant slaps in the face, discarding violins, pianos, double-basses and plaintive organs. Let us break out! "

He rejected traditional preferences for harmony, preferring the dissonant masterpieces that serenade us everyday without our conscious awareness. Pianos, violins, harps, and horns were considered inferior to "the crashing down of metal shop blinds, slamming doors, the hubbub and shuffling of crowds, the variety of din from stations, railways, iron foundries, spinning mills, printing works, electric power stations, and underground railways."

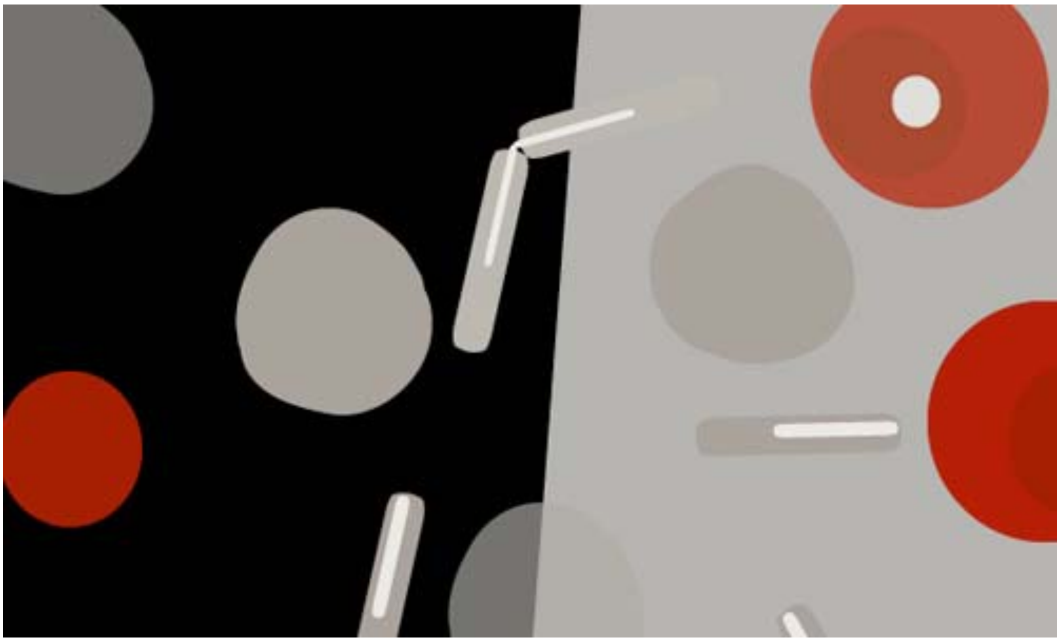
Russolo had a vision in which "every factory will be transformed into an intoxicating orchestra of noises". The instruments and music created by Russolo played a revolutionary role in the incorporation of noise and environmental sound into modern music.

We also explore our wonder with the fact that this new revolution – the software revolution – is entirely silent. What effect can the silence of software and the silence of this network life form have on the creation of music? For us it is an interesting contrast to use the network as a tool to generate a performance of sounds of the city; sounds that are a product of the industrial revolution, and what better place to gain source material for a Futurist music performance than the city of Hsinchu.

Over a period of time we gathered sound samples from various locations throughout the city of Hsinchu. We edited these samples and tuned them to a specific harmonic structure. We then fed these sounds, over a 100 in total, into our software agent which communicates with our carnivore server. The result is a cacophony of sound which could be understood as the city of Hsinchu acting as a Futurist Noise orchestra driven by network traffic.

3.8.1 The Installation

This installation was primarily audio based and can be experienced on the projects website. Below are some visuals from the limited visualizations that were projected in addition to the audio. Also included are photos of the installation itself.

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3.9 Windchimes

"During retreats Thay (Thich Nhat Hanh) encouraged participants to give calm, bright-eyed attention to each daily activity, whether eating a meal, drawing a Buddha, or just walking quietly, aware of the contact between our foot and the earth which supports it. In order to encourage this kind of mindfulness, a 'bell master' sounded a large bell regularly, and everyone stopped their activity, breathed three times, and recited silently, 'Listen, listen, this wonderful sound brings me back to my true self.' 'A bell is a bodhisattva,' Thay said, 'It helps us to wake up.'" (Peter Levitt, 1988)

Windchimes are in their natural state a musical instrument, a percussion instrument, but when augmented with sensors, windchimes become a minimal interface to access some kind of digital information and not only are they in themselves a container of information, in this case sound, but they then become a controller. A tangible interface to sound performance.

Windchimes is in line with our goals for creating interfaces for controlling and manipulating sounds that are transparent and invisible to the user and that elicit a sense of surprise when used. Windchimes were the last piece that we developed for the exhibition and in many ways one of the more interesting pieces, with varied influences which led to the concept being developed.

The windchimes fall a little bit outside the realm of my original study. They fit very much within the overall goals and concept of the project but the need to develop this instillation came from the exhibition itself. The idea was that the exhibition needed an installation, a piece of work, that would bring people into the entrance of the gallery. The gallery space itself does not have a very well defined entrance and the exhibition space itself, being all black, does not have a very well defined entrance either. So we wanted something specifically for the purpose of luring people in from the gallery entrance into the entrance to the exhibition. In coming up with the concepts which would fit this use, one of the first ideas I had came from my experience traveling in Thailand and in Nepal; and that is as you enter a temple in Thailand first of all when you are inside the temple itself you walk around in a clockwise motion, touching bells and touching cylindrical shapes as you walk around. But in Chiang Mai in Thailand I believe, at the Doi Sut, that temple, there is at the entrance to the temple a large collection of bells which lead you into the temple. So my first concept was that we could create bells from the entrance to the gallery until the entrance of the exhibition that people would touch and ring as they went through and of course these bells would be augmented with sensors to relay even more digital information. Of course in Buddhist practice 'Buddha' means to awaken so the sound of bells and bells themselves are very central to Buddhist practices and these bells that you find generally in these kinds of temples tend to be at least the large ones usually heard in isolation and their sound is actually very very complex and this sound had a very strong influence on the kind of sound I was going to create in this installation. Generally the smaller bells are less tuned or untuned and are arranged in large sets around temples in Thailand. Devotees strike each bell for forgiveness of a sin as they ascend into the temple. I cannot understate the complexity of sound that this creates when they are all rung at the same time. But as we came closer to developing the prototype we realized that the construction of a bell is fairly complex. What we eventually settled on was something which is very common to the surroundings of Taiwan and that is bamboo. Bamboo has a sound when struck all of its own which also, though in a minor sense, fits in well into the concept that we were trying to create. And the idea of windchimes themselves, they naturally invite you to put your hand across the chimes gradually from one end to the other. A very similar action as you would see in the Thai bells. So we settled on using bamboo windchimes in place of cast iron bells for primarily practical reasons. But I stuck with creating the sound that I remember hearing in these bells in Thailand and Nepal. So that when the people enter the gallery they would touch the windchimes in a forward motion and not only would the sound of the wood hitting one another create sound but the sensors would activate a very complex sounding iron bell influenced sound as well. And when all of these are touched at the same time the sound is very much like what I heard when in Thailand and Nepal.

The sounds themselves were created digitally based on various bell sound samples and various effects and reverbs in LogicPro 7. The complexity of the sound that I created was naturally quite a bit different from what you hear in a temple but it reflects a little bit of my experience in that I created not only an individual bell sound but then for each sound triggered by the windchime interface I would play a specific chord. This would be what we call a dominant structure chord which would contain a root, a third, a fifth, and a dominant seventh note. The windchimes themselves were tuned but not in a scale fashion. I chose to use the cycle of fifths throughout all the windchimes so that when you brush past them you would go through the cycle, the cycle of fifths, considered the most powerful root movement in music. I used that on purpose to try and lend even more power to the sound coming out of the interface itself. In the end the result is something which is very, very tense and very, very strong and really does tell people to wake up, open your ears, and come into the exhibition.

3.9.2 Installation

The following are photos of the installation itself.

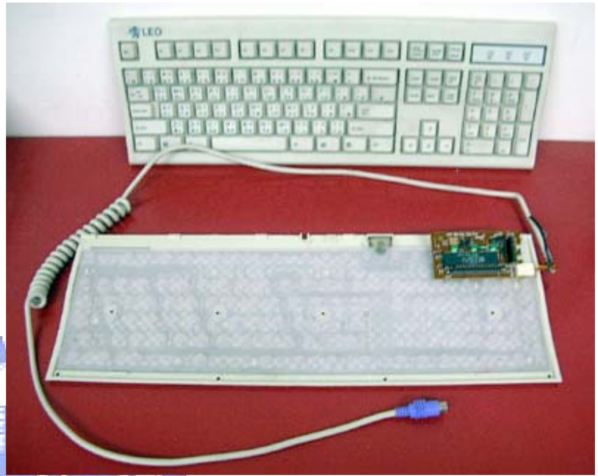
3.9.3 Technical Design

The windchimes consisted of 15 tuned bamboo poles hung with wire and connected to an IBM laptop that played the sounds through common computer speakers. The bamboo poles had embedded which communicated through the serial port to the PC. A simple flash client was activated and played pre-created sound.

In Windchimes the main affordance is sound through motion. The user interaction with windchimes was designed to be one directional but in practice there are more complex interactions that can take place. In selecting a sensor I was looking for something that could sense movement and be acquired cheaply and quickly. I found that simple mercury switches suit my needs. The mercury switch is a very small glass container with mercury inside which when balanced properly will detect motion and complete a circuit. I got lucky in acquiring these switches as quickly as I did as I was told initially that because

they are apparently also well suited to the creation of explosive devices permission must be granted for their purchase. Luckily I had no problems.

The serial interface was again a disassembled PC keyboard but a different approach was taken from the first attempt to use this method in Hullabaloo. Instead of working with the plastic circuits the breadboard of the keyboard was dealt with exclusively. This did involve some minor customization.



After taking apart a number of keyboards a model made by LEO was chosen due to an easier to understand breadboard. The spec. of the keyboard used was a LEO Model no. KWD-203.

One the main reasons for using this serial interface is it doesn't require any low level programming to communicate with a PC – the drivers and libraries needed are already in place. The client environment I chose was flash which allows for rapid development using Actionscript. This approach has worked quite well with the exception that two keys cannot be pressed at any one time. Perhaps a different approach can be attempted in a later revision.

When we use this particular serial interface we are replacing with our switch the action of a key press. I substituted the keys with the mercury switches.
The keyboard has 2 layers of plastic printed circuit and a blank slide with holes with respect to each of the keys between them. The top layer and bottom layer are separated in the default state. When a key is pressed, 2 layers will meet at certain hole and form a circuit. There is a small breadboard dealing with the signals from the layers and sending to PC. The top printed circuit has 18 pings and the bottom one has 9 connected to the breadboard. Pair them to get all the signals of a keyboard.

The technique I use to map wires to the breadboard I call the matrix. Next I will attempt to explain the reasoning behind this and show how I created this very durable interface.

After I opened the selected keyboard and took apart the breadboard from the plastic print circuit, I used an avometer to locate which ping is used by which keys and created the following table:

(x:ping number of top layer(1~18) / y:ping number of bottom layer(1~9)):

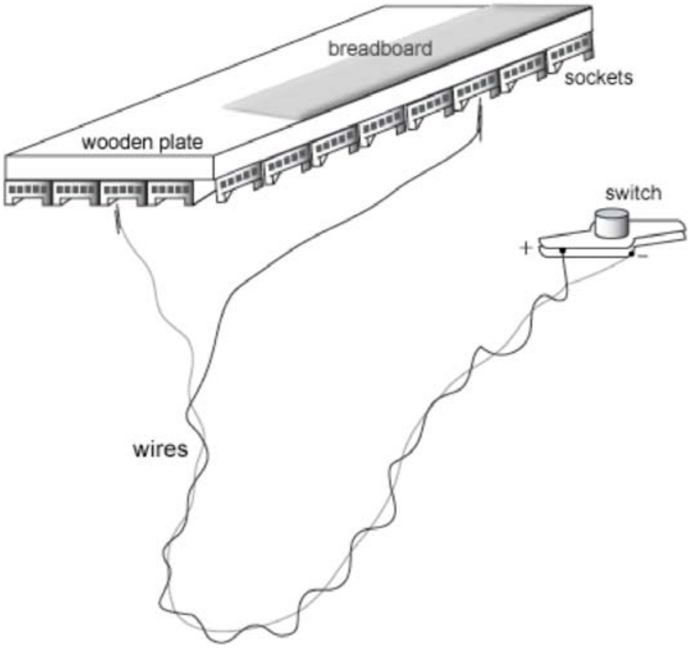
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1		CTRL+F					RIGHT CLICK			3	2	]	\		1	4		5
2							R			E	W	[			Q	R		T
3				=			F	=		D	S				A	F		G
4				BACKSPACE			V	BACKSPACE		C	X	\	‘	RIGHT	Z	V		B
5	6	7	8	9	-	1	9			2	3	0	ENTER					TAB
6	Y	U	I	O		HOME						P						
7	H	J	K	L														
8	N	M																
9																		

I can use a 9 by 18 matrix to represent all the keys of a keyboard (I usually just fill in what I need so some cells are blank). So you can find that:

- the entry in the (3,15)-th position of the matrix means "a"
- the entry in the (4,18)-th position of the matrix means "b"
- the entry in the (4,10)-th position of the matrix means "c", etc.

You can see that every ping is shared by many keys; since we only need those keys of letters, it is enough to prepare 5 connections for each ping and so I used 1 to 5 sockets.

With the help of this matrix, I melded all the wires to the breadboard and collected all the wires' other side to make sockets for switch's wires to plug in.



And in the last step, I fixed it on a wooden plate. The following is the pictures of the finished result.

The rest of the procedure is combining the keyboard and switches.

The diagram shows how a switch connects to the matrix. Every switch has 2 wires(+,-) and the wires will be plugged into x-sockets(top layer) and y-sockets(bottom layer) respectively.

It is exactly the same as when a key is pressed/released when the switch is turned to on/off.

Using this procedure we can connect any key of a keyboard to any kind of on/off switch. And we can also program an application that will be executed when a certain key is pressed or released.

4. Conclusions

I have presented Hullabaloo, Adult Chairs, Musical Squares, and Windchimes, simple tangible interfaces for the creation and sharing of musical and sound events. I also presented Traffic 1, 2, and 3, Girls Ambient Room, and Guidebot which collectively provided people an opportunity to reevaluate how they perceive music and sound. Presenting these prototypes and art pieces has allowed me to explore mine and others relationships with sound art , tangible and ambient interfaces. By embedding elemental sensors in familiar objects people were able to express themselves through music without the need for instruction both locally and with remote participants.

Criticisms

During the course of the exhibition I collected informally comments with regards to the exhibition in general and the individual pieces in particular. The informal nature of this data collection was in error as I missed an opportunity to collect valuable quantitative data that could have been used to guide further iterations of this and future work. Furthermore, I received some very important feedback from individual members of the thesis committee. The following are the highlights.

Many people were suitably impressed with the scope of the exhibition, especially when introduced to the challenges that were apparent in my choice of exhibition space. Despite this many expressed further that many of the pieces were not suitably displayed. With pieces of sound art the sound naturally bleeds from one space to the next interrupting or influencing the experience in each individual installation. Sound art is therefore very demanding in terms of the space in which it is exhibited. I realized this to an extent when this space was chosen but financial resources would not allow for the rental of a perhaps more appropriate venue.

The work was not interactive enough. This was a criticism leveled on more than one occasion and in one case in particular it was suggested that the length of time that someone was engaged was far too short to be rewarding. It was stated that I was competing with the attention span of video games which keep the player engaged in the experience for extended lengths of time. These are certainly correct observations but unfortunately they miss the objective that the project and the exhibition held. I repeatedly stated the contention that this was an investigation and exploration into various ways in which we can interact with digital information. We were iterating on the simplest forms of interaction with interfaces that were very intuitive. Long complex interactions do not necessarily denote quality nor do they indicate success. The exhibition served more as a report on this progress than the final product. I've mentioned in conversations since the close of the exhibition that many of the ideas presented were in their current form simply the first of many iterations to come. They were deliberately unfinished and unpolished. My failure was to not communicate this far more effectively. The exhibition was too large in scope and produced in too short a period of time to allow for a game quality experience in terms of the length of time people would experience the installations. It's my belief that at this stage creating longer more interactive experiences was not necessary to meet the goals set out in the project. Furthermore, my observations indicated that people were engaged and enjoyed the interactive pieces for what they were. Lastly this criticism ignores the fact that half of my work was not interactive but conceptual and as a result a passive experience.

The exhibition didn't introduce any new uses of technology, didn't introduce new novel technology, or didn't use technology that was 'homegrown'. In building interfaces that were hidden from casual observation and embedded within everyday objects there are going to be some questions related to how the installations were engineered. I welcomed these questions as I was particularly proud that I was able to build the installations quickly and under great budgetary constraints. I was striving to iterate on interfaces for the purpose of seeing the interfaces in use as quickly as possible. I had an ambitious plan to build a new interactive prototype every three to four weeks and under those conditions my greatest concern was meeting the deadline using whatever tools I could acquire. I was not concerned with observing engineering innovation as much as interface innovation.

Whenever possible I used off-the-shelf parts to repurpose for different uses. I took apart a wireless bluetooth keyboard to create an elemental wireless set of sensors for use in Hullaballoo. Initially I did the same for Adult Chairs but eventually purchased a sensor system from a Canadian company. I built the sensors used in Windchimes and Music

Squares from common parts found in a hardware store. This facilitated rapid prototyping but many naturally disagreed or were disappointed with this approach.

It's difficult to respond to this criticism further. It would have been beneficial if at even at this early stage of the projects development if I could have used sensors under development by my employer the Industrial Technology Research Institute. But many that we were interested in simply weren't available, weren't ready, and I didn't have the time and ability to track down all possibly interested parties who might be willing to get involved. I felt it was better to produce prototypes now, create novel interactions, create art, and then later use these examples to bring more people into the project to create more robust iterations later on. I believe worrying if ideas or tools originated elsewhere inhibits innovation, it does not encourage it.

Future work

I am currently working on developing several aspects of this work more thoroughly. I plan to continue to explore how we interact with and perceive our relationship with sound and music. Hopefully with proper funding a more rigorous research and prototyping program can be introduced in order to create more valuable outcomes and solve problems inherent in the human-computer interface with regards to music and sound production.

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