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DESIGN:  
DESIGN REPORT FOR HOMENETTOO PROJECT

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*Frank Biocca*

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**SPATIAL INTERFACE AND INTERPERSONAL INTERFACE DESIGN:  
DESIGN REPORT FOR HOMENETTOO PROJECT**

**By**

**Ming Tang**

**A THESIS**

**Submitted to**

**Michigan State University**

**In partial fulfillment of the requirements**

**For the degree of**

**MASTER OF ARTS**

**Department of Telecommunication**

**2003**

## **ABSTRACT**

### **SPATIAL INTERFACE AND INTERPERSONAL INTERFACE DESIGN: DESIGN REPORT FOR HOMENETTOO PROJECT**

By

Ming Tang

Three computer interfaces - a standard web interface, a spatial interface, and an interpersonal interface were constructed for experiments that compared the effect of different interfaces on a person's knowledge gained with respect to their cognitive styles. The standard web browser interface presented information in magazine-style and was used as a control condition for the experiment. The spatial interface was a three-dimensional environment where a test participant used a joystick and mouse to navigate around different buildings with information presented as posters within the buildings. The interpersonal interface used computer-generated talking avatar as an agent to help test participants to access information.

This thesis is dedicated to my dear parents, thanks for all of their encouragement and support during my education career.

## ACKOWLEGEMENT

Thanks to Dr. Frank Biocca for his supervision and kindly help during my working in M.I.N.D Lab. Thanks to Dr. Carrie Heeter for her advice, and help revising my thesis. Thanks to Professor Brian Winn for his advice and professionalism in teaching. Thanks to Dr. Hairong Li, Professor Robert Alberts, Joy Mulvaney , Lynette J. Lim, Arthur Tang , Zena Biocca, Chandan Reddy, Weimin Mou, Geraud Plantegenest, Chad Harms, Leavitt Blain, Kevin Lim for your help during my studying in Digital Media Art and Technology program in Michigan State University. Thanks to Brian Emerson, Jason Justice for their kindly help during my working in Institute for Creative Technologies, University of Southern California. Thanks to Matt Block and Sitthi for their hard working on the sound effects of my CG animation. Thanks to all the faculties and staffs in Telecommunication Dept, MSU. Finally, thanks to my wife, Dihua, for her endless love and support.

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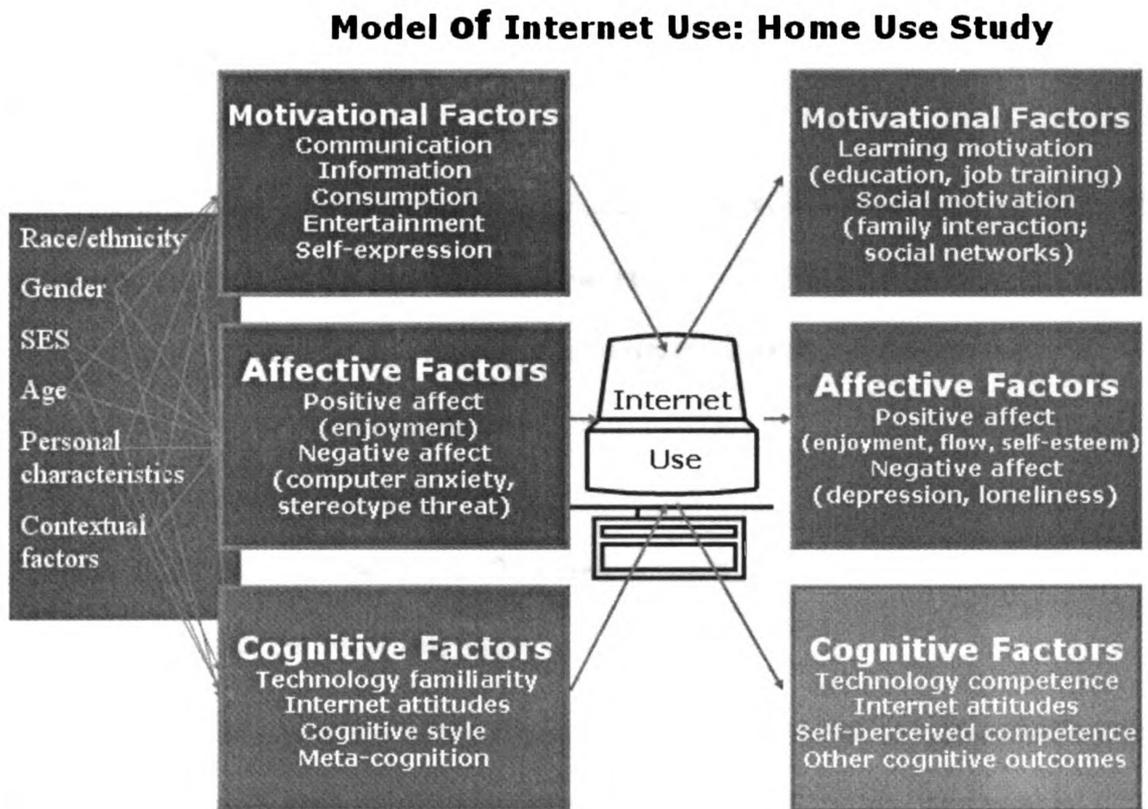
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## INTRODUCTION

The HomeNetToo project is funded by the National Science Foundation (NSF). The main purpose of the project is to examine whether there are other factors besides income that contribute to the digital divide in societies. There are several studies within this larger project<sup>1</sup>. The theoretical model of this study is illustrated in Figure 1.



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<sup>1</sup> HomeNetToo - <http://www.homenettoo.org>

Home Net Too began as a multi-method, interdisciplinary research project that examines the antecedents and consequences of Internet use in low-income families. A central research effort is a longitudinal field study, begun Fall 2000. Participants were provided computers for a year. Their Internet use was continuously computer-logged, and surveys are administered 5 times during home visits at pre-trial, one-month, three-months, nine-months and post-trial. Full tech support is provided in the home by undergraduate "technology facilitators." Analysis of the early logging

**Figure 1: Theoretical model of HomeNetToo. By Dr. Linda Jackson and Dr. Frank Biocca.**

This design report upon here was part of an experiment that involves testing the interaction of different type of interfaces with the cognitive and learning styles. Specifically, the experiment explored whether the match of interface type with cognitive style improves learning, presence, and attitudes towards the interface, content, and information source. As a part of the HomeNetToo project, M.I.N.D Lab<sup>2</sup> designed three interfaces to test these hypotheses.

The design challenge was to provide the same material to the participants in the experiments while varying interface styles. This thesis is a description of entire design process. It is a report of experiment team<sup>3</sup> and design team<sup>4</sup>'s decisions made on three interfaces:

1. Regular-style web interface.
2. Spatialized three-dimensional (3D) environment
3. Interactive interpersonal interface.

Instead of cover the entire research and experiments of HomeNetToo, my thesis only focus on the design process of the three interfaces. The goal is creating the materials the experiment team required, making three interfaces

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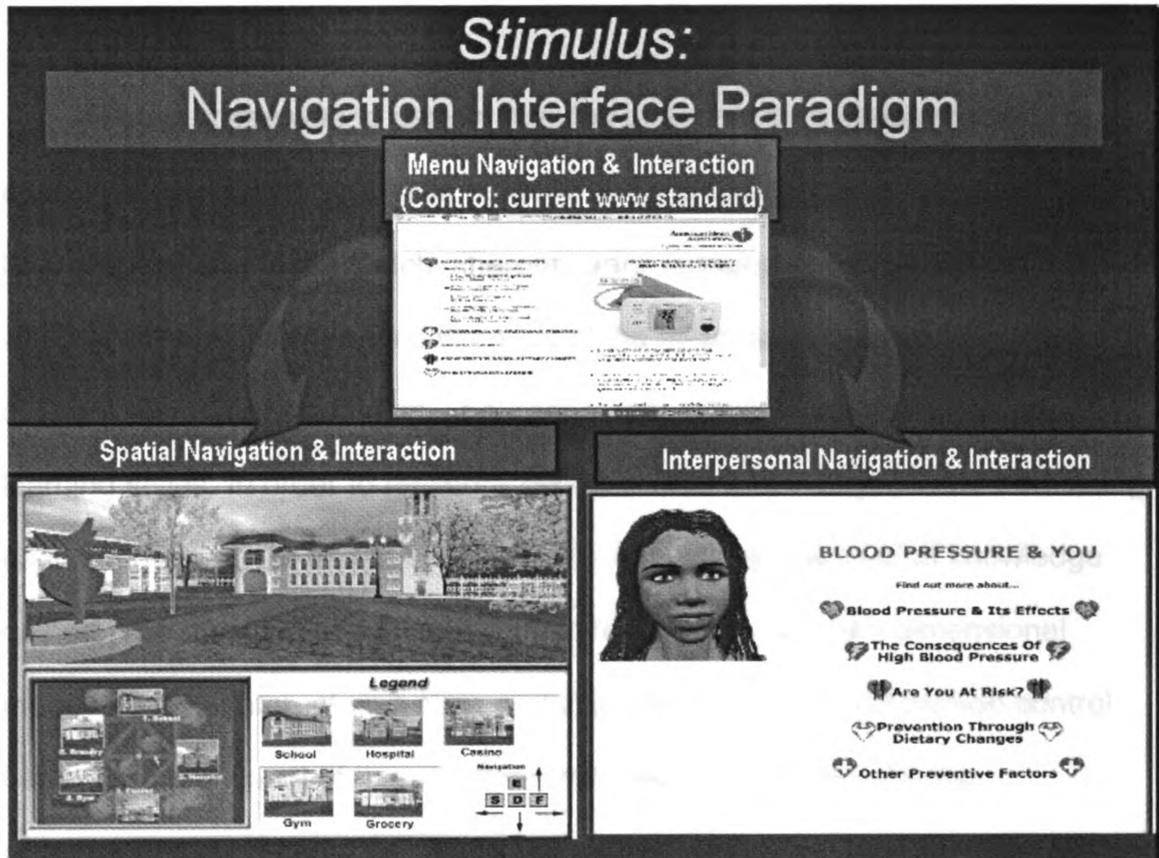
data suggests relationships between cognitive style and Internet use. Another research study uses ethnographic research to examine Internet usage, its meaning, and role in the family unit.

<sup>2</sup> HomeNetToo staffs in M.I.N.D Lab: Dr. Frank Biocca, Lynette Lim, Ming Tang, Weimin Mo.

<sup>3</sup> Experiment team: Frank Biocca, Lynette Lim, Weimin Mo.

<sup>4</sup> Design team: Lead designer: Ming Tang; Intern students: Blain Leveet, Kevin Lim.

available for the experiments. So, my thesis does not include any research hypotheses, data collecting and analysis.



**Figure 2: Three interfaces**

## **CHAPTER 1. DESIGN BACKGROUND**

The design context is determined by the purpose, audience, information content, and design criteria of the project. These are defined below.

### **1.1 Purpose**

The purpose was to design stimulus materials for a series of interface usability experiments. The main purpose of the experiments was to investigate how different interfaces match different users' learning styles, specifically, whether 3D and interpersonal interface of the information presentation have different advantages on users' knowledge gain to the users' with different learning styles. In order to measure the amount of knowledge gained from using each interface, there has to be a yardstick to compare the level of knowledge gained. The most commonly used computer interface is a two-dimensional magazine-style Internet web page and that was used as a comparison control base. Taking account of this standard, the designer working with the experimental team came up with two alternative navigation and interface design approaches, a 3D spatial interface and an Interpersonal interface. These are described in greater detail below.

### **1.2 Audience and Topic**

Many of the participants recruited for HomeNetToo project were from low-income families. 67% of the participants are African-American and 80% are female.

Hence, the fundamental decision before any design commenced was to select a topic that would be of interest to the participants. Because participants tend to be more motivated to learn when a topic directly affects them, the experimental design team selected high blood pressure (HBP) as it is a condition that tends to have a higher occurrence in African-Americans and women than the rest of the population<sup>5</sup>. This health-based topic should also appeal to populations that fall outside the demographic because health is a primary concern of most individuals. Even if someone does not suffer from high blood pressure, they may know someone who does.

### **1.3 Information content**

The script for the content was obtained from various sources and repeatedly tested for clarity and cohesiveness. The experimental design team decided and organized contents into five separate but distinct sections: (1) HBP effects; (2) HBP consequences; (3)HBP risks; (4) prevention HBP through diet; and (5) prevention HBP through exercise.

### **1.4 Design criteria**

Because this design was to be used for an experiment, the design criteria had fixed items to be kept the same across all experimental conditions, and variable design features to vary according to the experimental design.

#### Fixed design features

---

<sup>5</sup> American Heart Association Website. Available at: <http://www.americanheart.org>

The following items needed to be exactly the same across all conditions

- All text
- All images
- The basic “page” arrangement
- The background of the pages
- The fundamental groupings and categories of pages

Variable design features

- The means of navigation
- The overall look and feel of the interface

## CHAPTER 2. THE STANDARD CONTROL INTERFACE

A regular web interface was created first, which would eventually be used as a control condition to the spatial three-dimensional environment and preserve as much content and design as possible between the two conditions. The same requirement was applied to the interpersonal interface design.

From a design viewpoint, the goal here was not to innovate but present a “typical” web interface.

### 2.1 Navigation

The navigation technique for this site were similar to the “average” standard website that were found on the web in 2002. The navigation method was based on menus presented to the left of the content.

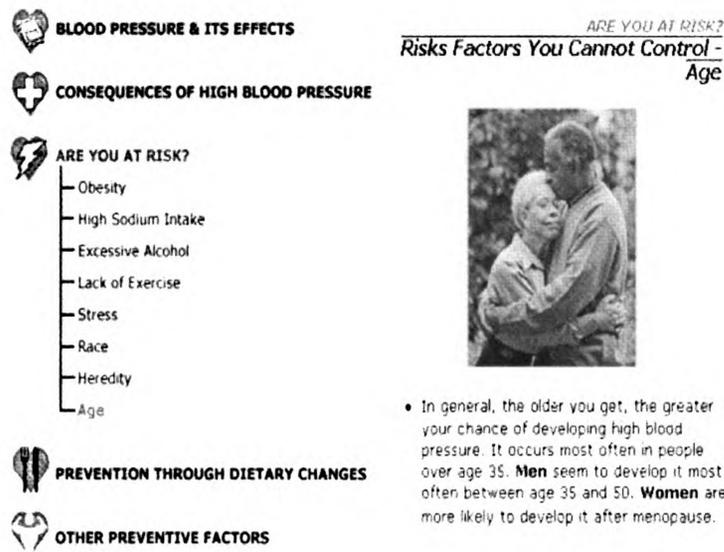


Figure 3: standard control interface.

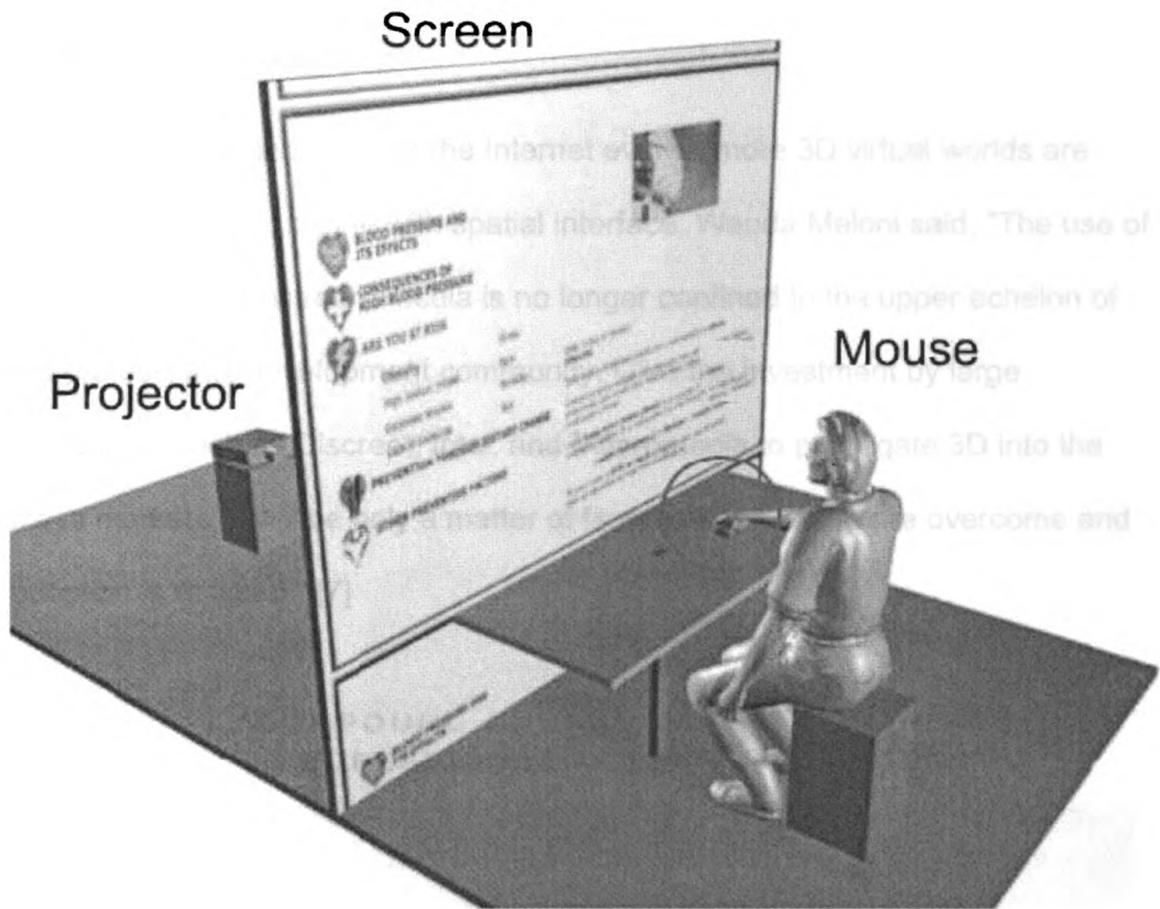
## 2.2 Design features

Icons were designed to represent these five sections. Ossner [1] explains that iconic signs represent similarity and show importance in the content that one can expect. Each icon was a symbolic emblem of its topic section, mainly: (1) a book to represent HBP effects; (2) a cross for HBP consequences; (3) a lightning bolt for HBP risks; (4) a fork and knife for prevention HBP through diet; and (5) a flexing figure for prevention HBP through exercise. Each icon was then placed upon a red heart background to refer to and link it to the broader topic of high blood pressure. These icons were reproduced in all three interfaces to preserve the similarity and hence remove the possible confronting effect from icons across them.



**Figure 4: Icons for five contents. By Lynette Lim.**

In the experiment, participants are assigned randomly to three interfaces. The assigned interface was projected to a big screen. The participants used a mouse to navigate the HBP content with the Internet browser in the case of control interface.



**Figure 5: Experiment for control interface.**

## CHAPTER 3. SPATIAL INTERFACE

### 3.1 Background research

As 3D technology and the Internet evolve, more 3D virtual worlds are being implemented online with spatial interface. Wanda Meloni said, "The use of 3D content in mainstream media is no longer confined to the upper echelon of the professional development community. Give the investment by large companies such as Discreet, Intel, and Macromedia to propagate 3D into the mass markets, it will be only a matter of time before barriers are overcome and adoption is realized." [7]

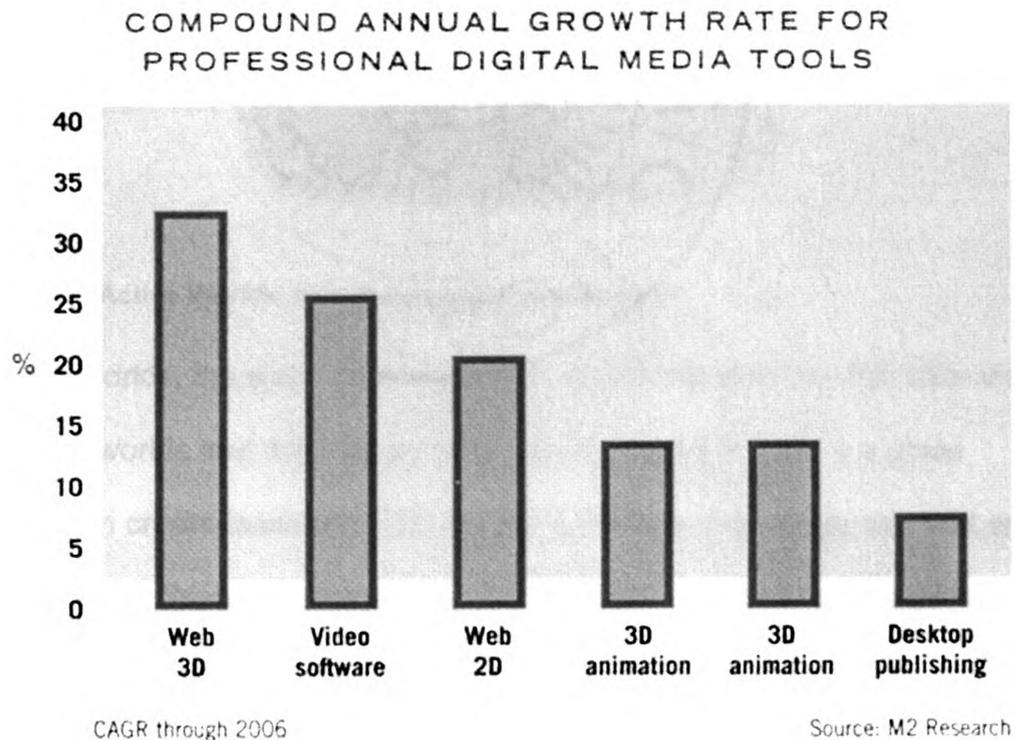


Figure 6: Growth rate of Web 3D. By Wanda Meloni. M2 Research.

The compound annual growth rate for Web 3D up to the year 2006 is 32 percent, which leads all other categories in terms of digital media tool growth.

The HomeNetToo design team did research on several online 3D world examples, including Active Worlds, Adobe Atmosphere, Unreal Game world, and Director Shock Wave 3D world.

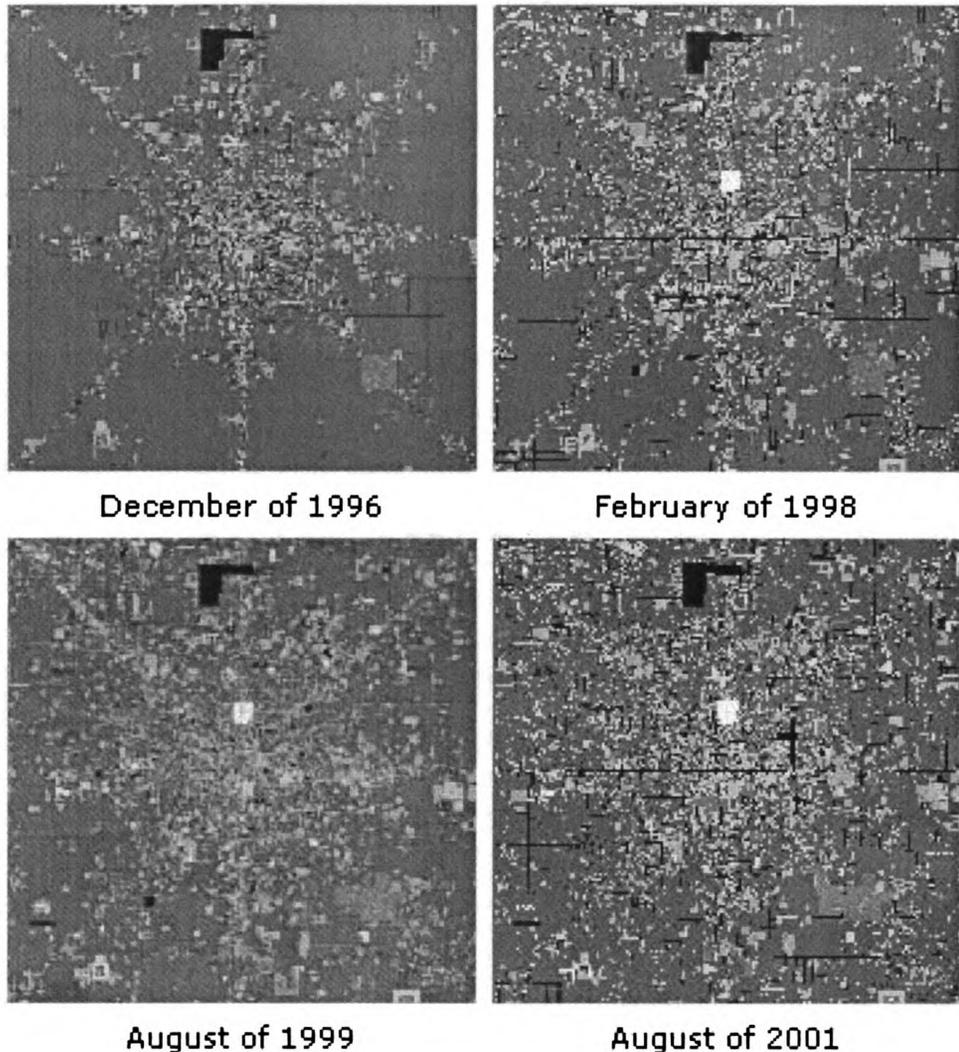
### 3.2.1 Active worlds.



**Figure 7: Active Worlds. <http://www.activeworlds.com/>**

Active Worlds, the web's powerful Virtual Reality experience, lets users visit and chat in 3D worlds that are built by other users. Active Worlds is a place where users can create fascinating 3D worlds in minutes that others can visit and chat in. The Active Worlds Universe is a community of hundreds of thousands of users that chat and build 3D virtual reality environments in millions of square kilometers of virtual territory. In Active Worlds users can take a claim to a piece of land and build their own virtual home, meet people from all over the planet that

can explore online shopping mall, and other peoples' virtual worlds, play online games.



**Figure 8: Satellite maps of Active Worlds. Fast growth of Virtual Metropolis.**

Satellite maps of Active World community have grown over the years.

“These are pictures of Active World taken in December of 1996, February of 1998, August 1999, and again in August of 2001 by Active Worlds. Notice how the community has populated the land with more buildings over the years, turning

it into a Virtual Metropolis. Each full picture is 2000x2000 pixels and covers the area between 1000n 1000w and 1000s 1000e, with ground zero being the center of the picture. The total area covered is about 400sq kilometers, and would take users over 2 hours to walk directly from one end to another (that is, two hours in AlphaWorld - it would obviously take much longer in real life). Despite their size, these pictures represent about 0.3% (that's one third of one percent) of the total area of AlphaWorld.<sup>6</sup>

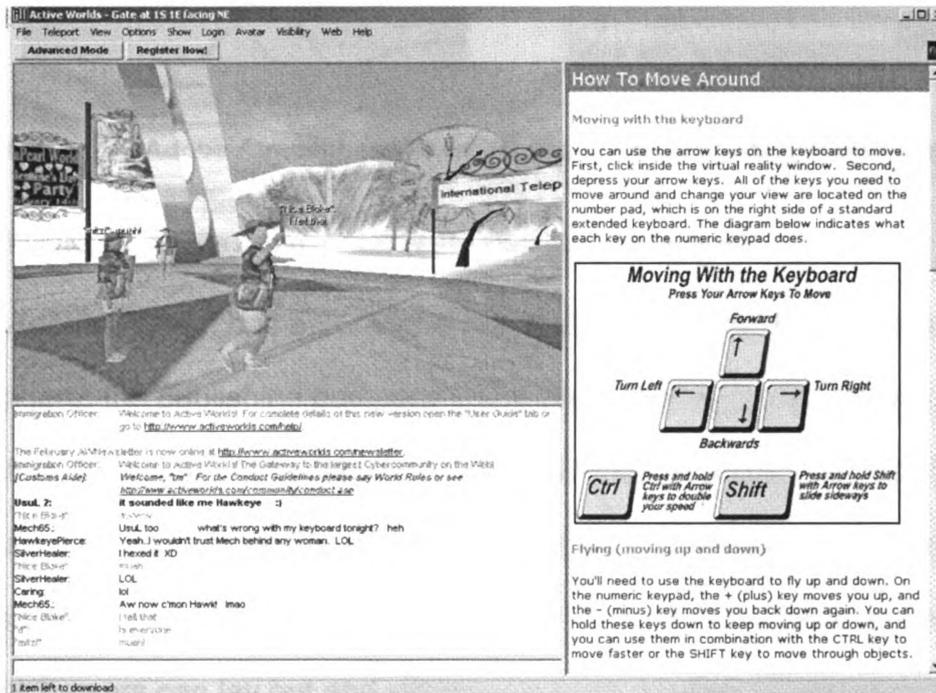


Figure 9: Interface of Active Worlds browser.

<sup>6</sup> <http://www.activeworlds.com/community/maps.asp>

### 3.3.2 Adobe Atmosphere world.



**Figure 10: Adobe Atmosphere 3D world. <http://www.atmospherians.com>**

**Figure 11: Adobe Atmosphere world Interface. Screenshot.**

Adobe System has entered the realm of real-time Web 3D with Adobe Atmosphere, the publishing company's first Web authoring and viewing tool for interactive 3D worlds. Atmosphere consists of three modules. The first, Builder, is aimed at 3D content creators and Web developers. It provides a palette of 3D objects-primitives as well as architectural elements such as doors and stairways-with which users can lay out and structure a room or other 3D environment. Since Atmosphere is based on Viewpoint's Media Player, models and animations created in third-party 3D applications such as discreet 3ds max or Alias/Wavefront's Maya can be directly imported into an Atmosphere world after being converted to Viewpoint. Developers may also use JavaScript to input animations and sound in Atmosphere.

Two Atmosphere modules are Browser and Community Server. Browser is a plug in that works with either Netscape or Internet Explorer. The 5MB plug-in is free, and must be downloaded before a user can view Atmosphere content. The Atmosphere Community Server is an Adobe-sponsored chat server that provides users with text-based chat and avatar applications.

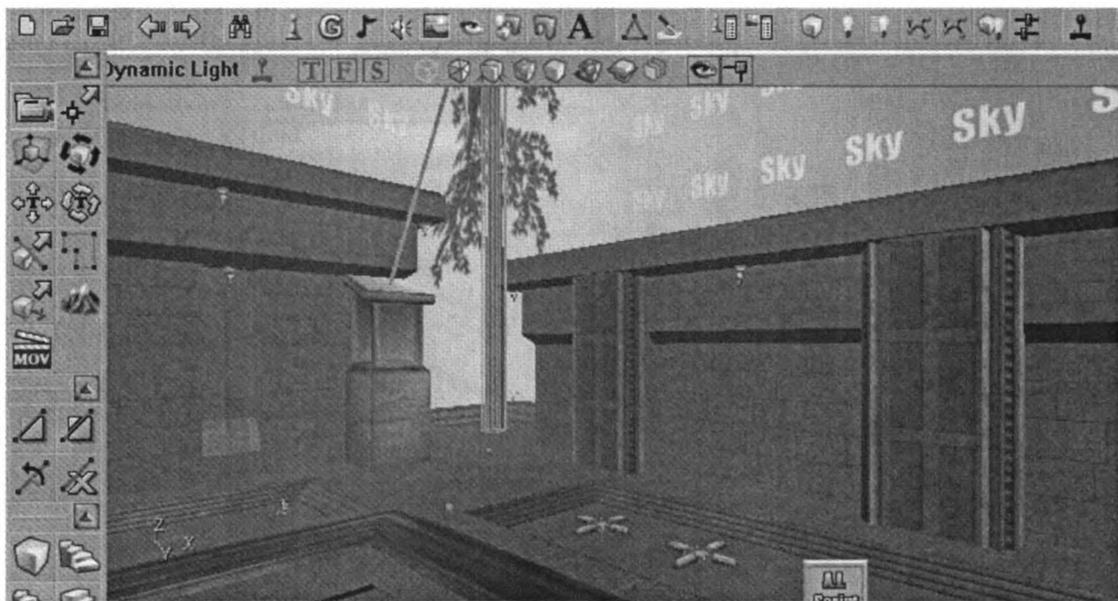
Curious Lab also published Avatar Creator to support this viewpoint based 3D world. Avatar Creator can create low-poly avatars that can be published into Atmosphere directly.

The experimental design team did not use Adobe Atmosphere in the spatial interface design because there is still a long way for Atmosphere to integrate multimedia into its virtual world. The 3D geometry imported from Maya or 3DSMAX had some problems for collision detection in Atmosphere's engine. Also, using Java Script to trigger the music, image, video clips in Atmosphere were still in the early developing stage and needed lots of programming work at this point of time.

### **3.2.3 Unreal Tournament game world**

Unreal Tournament (UT) 2003 is the sequel to 1999's multiple "Game of the Year" award winner. It uses the very latest Unreal Engine technology [6] - where graphics, sound and game play are taken beyond the bleeding edge. The Unreal Tournament game engine is famous for its fast rendering speed, and well-designed level editing tool. UT engine supports both Maya and 3D Studio Max. User could create their own levels, models and skins. Lisa Taylor said, "Some of

the artists and programmers in this emerging community were simply making 3D maps for new game levels. But most were going well beyond that, entirely rewriting the mechanics of their favorite titles-including the rules and physics-and offering new forms of play based on the original game engine.” [8] Unlike Quake, Unreal engine is strictly object-oriented. Michael Lewis said, “The Java like scripting language, Unreal Script, is easy to use and well documented as is the well-designed Unreal Ed development environment. Also, unreal engine has a broader range of sophisticated graphics including bump maps and other tweaks recently added to graphics hardware”. [6]

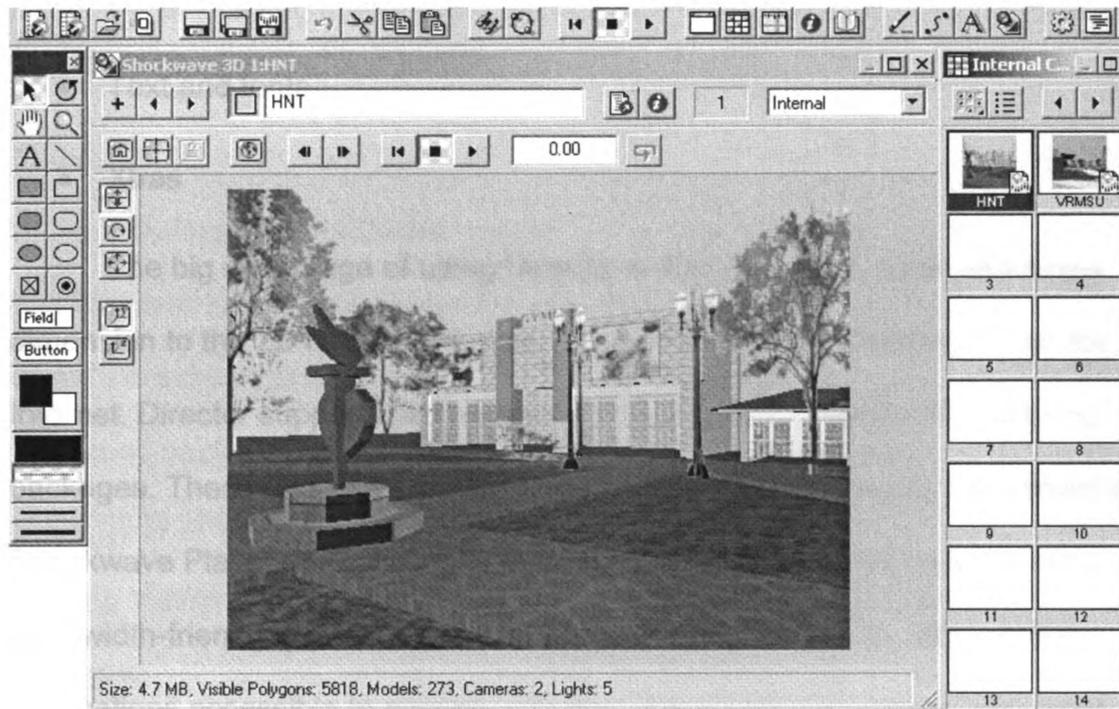


**Figure 12: Screenshot of Unreal Level Editor**

UT game engine had the potential to be used to design the HomeNetToo spatial interface for its wonderful real time rendering. Michael Lewis said, “Now the mass market for computer games, grown even larger than the movie industry, has expropriated the best in computer hardware and software for itself.

The most sophisticated rendering pipelines are now found not on specialized scientific machines but on PC video cards costing less than \$500. The most sophisticated, responsive interactive simulations are now found in the engines build to power games.” [6] Compared to expensive virtual reality (VR), augmented reality ( AR) , military and high-end VR lab’s technology, game engine/simulation are more practical to most generously founded researchers. CaveUT, GameBots are some examples of the test beds using UT engine in immersive and interactive research. ([www2.sis.pitt.edu/~jacobson/ut/](http://www2.sis.pitt.edu/~jacobson/ut/))

### 3.2.4 Director shockwave 3D world.



**Figure 13: Macromedia Director 8.5.**

With Macromedia Shockwave Director 8.5, Users can build rich content that delivers real results, integrating 3D, interactive audio, video, bitmaps,

vectors, text, fonts, and more. They can burn these contents on CD, DVD, or publish them in internets—to reach 300 million web users with Macromedia Shockwave Player. Users can create streaming, interactive, multi-user content using<sup>7</sup>:

- Interactive 2D and real-time 3D animation
- Video: Real Video, Apple QuickTime, AVI.
- Sounds: RealAudio, MP3, AIF, WAV
- Graphics: JPG, GIF, PNG, PSD, BMP, and more
- Macromedia Flash
- Text and fonts
- Xtras

The big advantage of using Director is that designers could add a new dimension to the 2D multimedia work—publish interactive real-time 3D on the Internet. Director supports files exported from the most popular 3D authoring packages. These files can be viewed on the web with the popular Macromedia Shockwave Player. 3D artists can use Director to transform 3D artwork into bandwidth-friendly games, interactive product demonstrations, and learning applications accessible to anyone with any kind of Internet connection—even dial-up.

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<sup>7</sup> [http://www.macromedia.com/software/director/3d/artists /](http://www.macromedia.com/software/director/3d/artists/)

Compared with Active Worlds and Adobe Atmosphere, Director has a better support both Maya and 3D Studio Max format models. Director's Lingo language gives designers more flexibility to control the multimedia content than Unreal engine and VRML. And the most important feature, Director model could be published to web and played in a standard Internet browser, but the Unreal Model will require user to download and install Unreal game before they see the 3D world. Based on the evaluation of these 3D editing tools, we chose Shockwave Director as our final design tool.

### **3.2 Concept design**

While creating the regular web page involved basic hypertext authoring skills, the creation of a 3D environment involved more complex decisions. First, the experimental design team had to organize the information into 3D structures. While in the regular interface it was easy to present the information with icons, graphics and text, the design team wanted to create a virtual environment in which the subject would feel immersed in the environment. Hence, as there were five broad sections of information, the design team decided to create a "cyber town" [3] to give the impression of an interactive virtual community, with each building representing one section of information that was presented in the control interface.

#### Criteria for the 3D interface

According the experimental design team this interface had to have the following design features

- **Spatial Organization:** Information categories are organized using spatial elements such as building, square and billboard.
- **Spatial Navigation:** Participants in the spatial interface condition will navigate through a three-dimensional virtual city using joystick to access the information.
- **Text located to billboard place:** The same information that participants view in the other two conditions will be presented on “billboards” in the spatial interface condition.

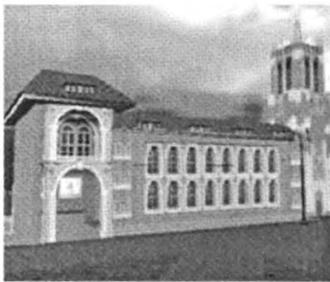
### **3.3 Design process**

#### **3.3.1 Spatial layout and organization**

The next decision was deciding on what type of buildings to create in order to be analogous to each of the five sections. Another question is how to organize these five buildings.

The experimental design team decided to use real world buildings to present the web contents. (1) A school building to represent high blood pressure (HBP) effects because school building often paralleled with institutions of learning; (2) a hospital to represent HBP consequences, because the cross used in the icon is often symbolically associated with hospital and other medical facilities; (3) a casino to represent HBP risks (while a little hard for others to comprehend, gaming institutions are often advocated in the local media as places of danger and avoidance in the community that we drew our subject pool from); (4) a grocery store with a fruit stand in front to represent prevent HBP

through diet; and (5) a gym to represent prevent HBP through exercise. The experimental design team created this virtual city using the real building's pictures as the reference, integrated the icons from the web interface into the 3D environment in natural ways, added a red cross for the hospital, sport posters for the gym and neon lights for the casino.



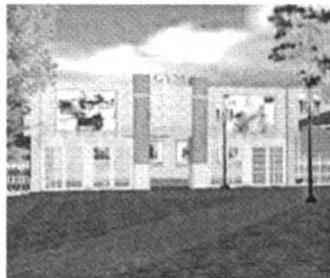
**School**



**Hospital**



**Casino**

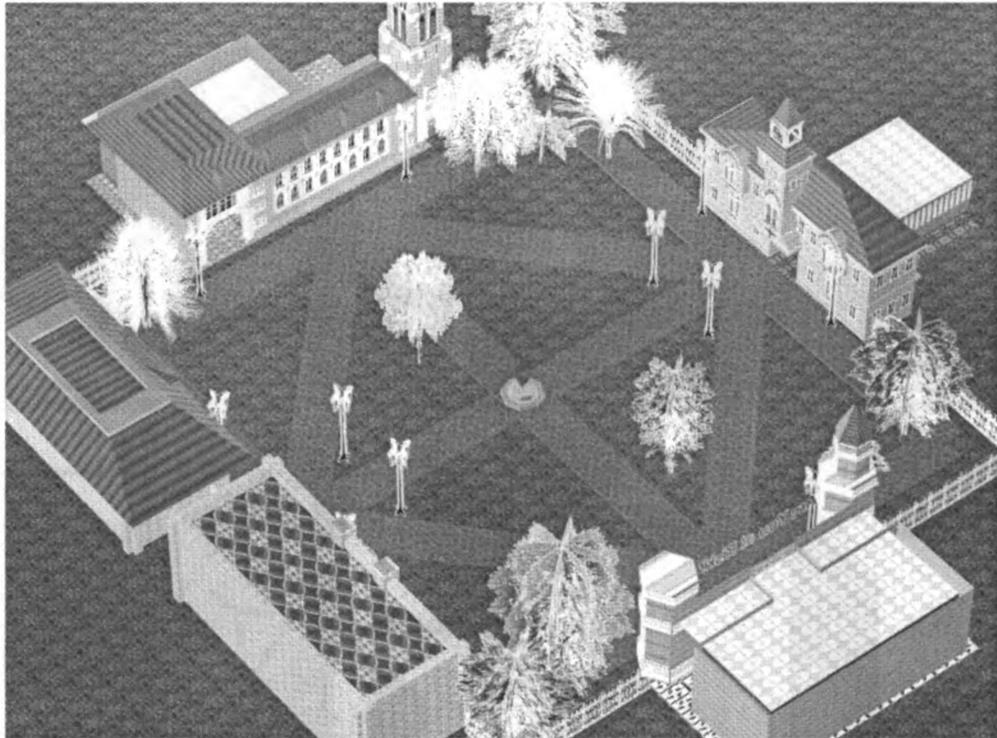


**Gym**



**Grocery**

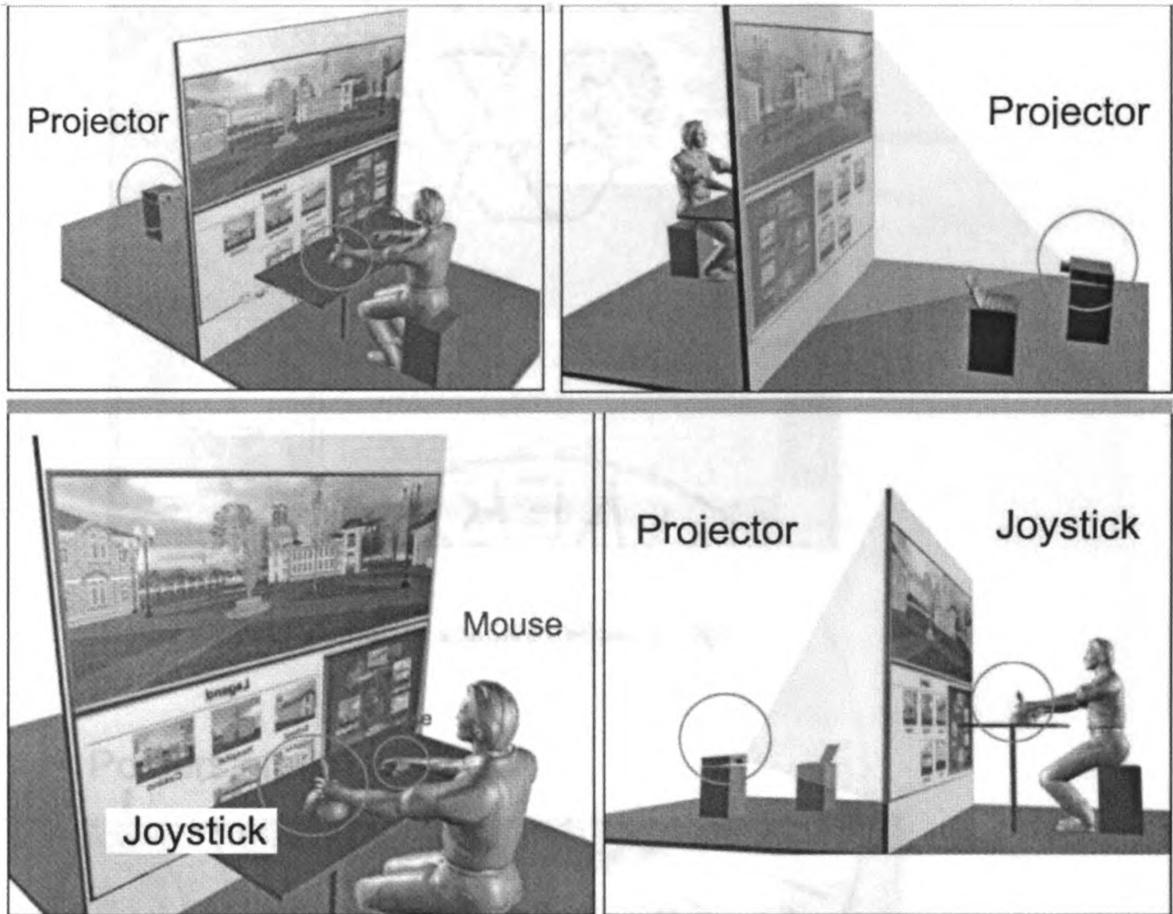
**Figure 14: Five buildings in the virtual city.**



**Figure 15: 3D model of buildings and environment in 3D Studio Max.**

### **3.3.2 User Interface and a navigation design**

Users controlled the joystick by the left hand and controlled the mouse by the right hand. They used the joystick to walk forward, backward and turn around. They used the mouse to click 3D objects and buttons.



**Figure 16: Experiment for spatial interface.**

All the HBP information was presented by posters on the wall within the building. When users clicked those posters, some relative HBP information popped up at the bottom of the screen.

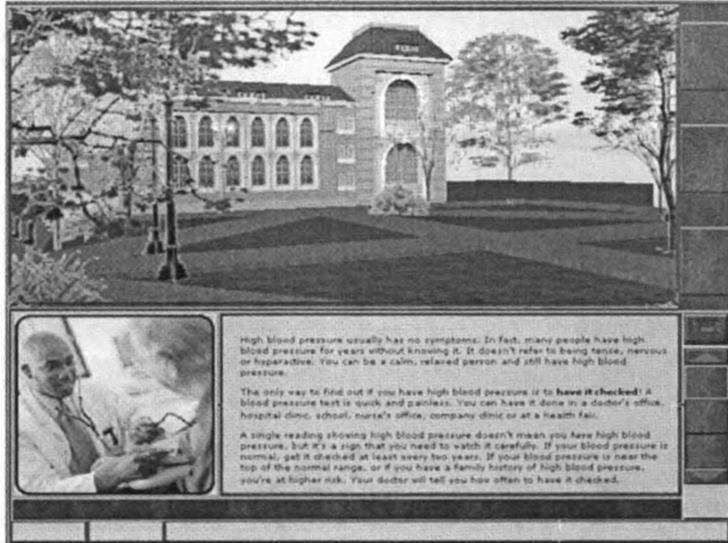
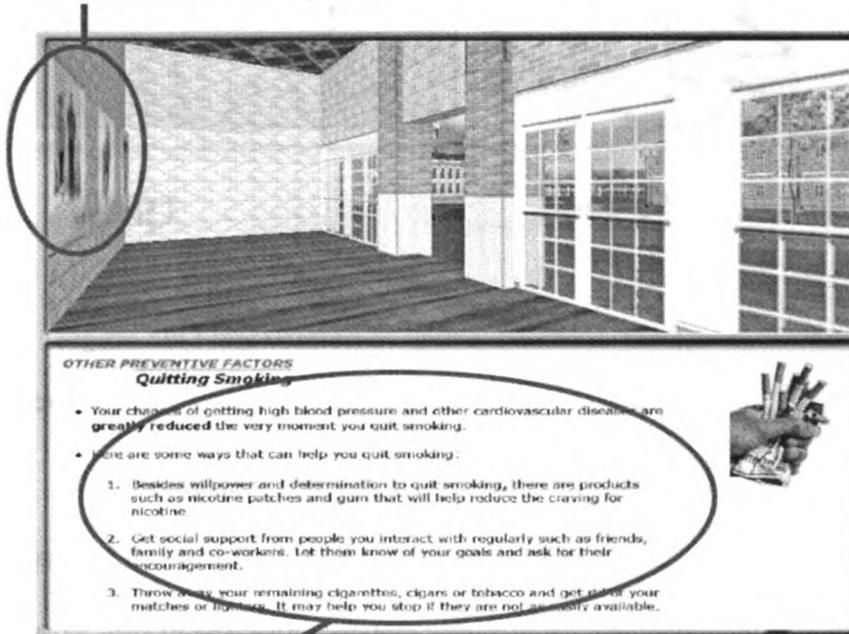


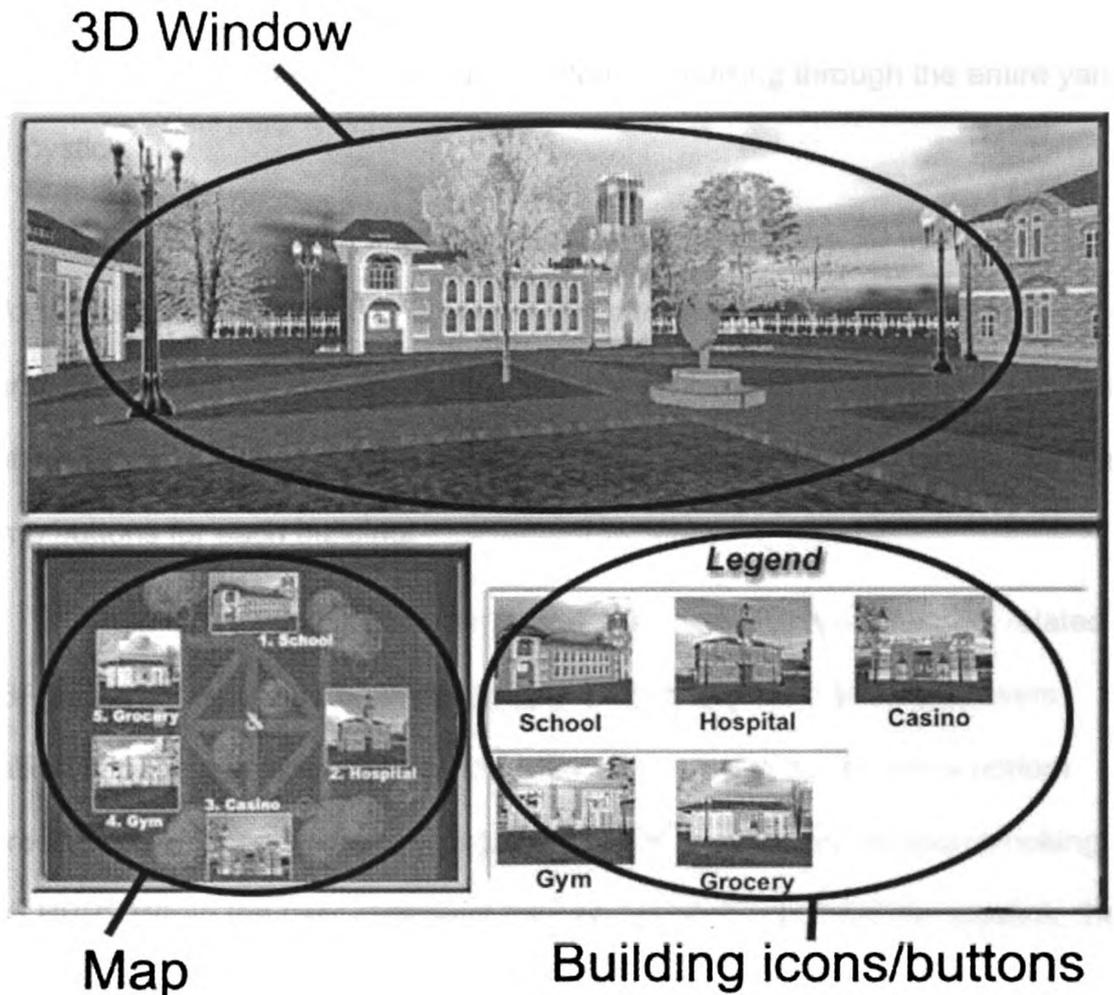
Figure 17: First version of spatial interface design

Posters on the wall



Text/2D images pop up when click posters

Figure 18: Final version of spatial interface. Screen shot when click the posters on the wall.



**Figure 19: Final version of spatial interface. Screen shot when users pushed joystick.**

The navigation map is on the bottom right of the screen, which shows the top view of the entire 3D city. An interactive arrow informs users their current locations and orientation. When users push the joystick and walk around in the virtual environment, they can tell their position and direction from the arrow in this map. There is also a jump button for each building. The experimental design team designed those buttons using building images. When users used a mouse to click one particular building's image (Jump button), they jumped directly to the

front door of this building in the virtual environment. These buttons gave users an alternative way to get to each building instead of walking through the entire yard by joystick.

Because the design team was required to present the 3D model and 2D information (text, image) in one screen, the whole screen was divided into two parts. The top screen is a 3D window that shows the main 3D environment. The bottom screen includes a small interactive map and some images which are the jump buttons for each building.

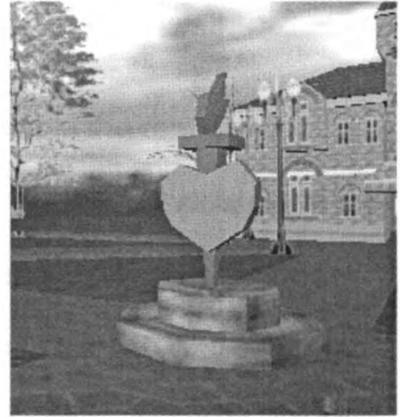
When users used the mouse to click the posters in the 3D world, related HBP information popped up in the bottom screen. For example, when users walked into the gym and clicked the poster about smoking, the whole bottom screen was replaced by the message about “the relationship between smoking and HBP”. When the user continued their navigation by pushing the joystick, the bottom screen switched back to navigation map and jump buttons.

### **3.3.3 Spatial cues and environmental design**

The experimental design team created five buildings placed in a square and created a fence around this square to prevent users from wandering outside the environment. The design team also created a sculpture in the center of the yard. This sculpture was created based on the 2D logo of American Heart Association. (<http://www.americanheart.org>). The design team extended this 2D logo into 3D sculpture and put it in the yard as a landmark.

# American Heart Association.

**Fighting Heart Disease and Stroke**



**Figure 20: American Heart Association's 2D logo.**

**Figure 21: Screenshot. 3D sculpture in the virtual yard**

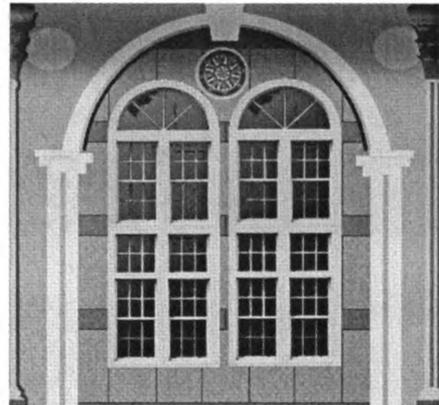
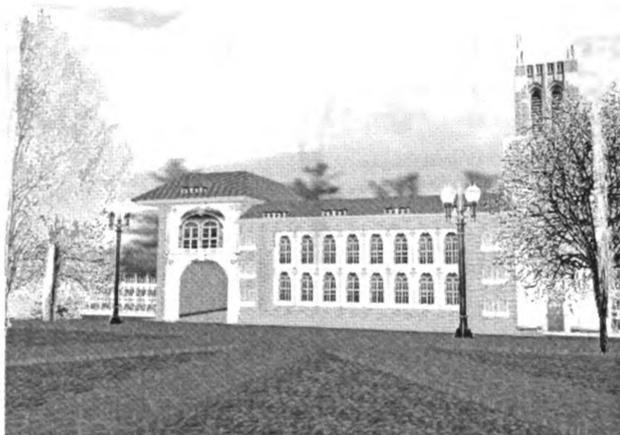
The design team also put some trees, light poles and bush in this yard to make the environment looks more realistic. The sky is a large-scale half sphere on the top of ground. The design team added several blue lights to light the top part of the sky.



**Figure 22: Sky sphere and central yard.**

### 3.3.4 Texture design

Because the entire 3D model had to be rendered in the real time by shockwave director's rendering engine, high polygon models will slow down the frame rate significantly. The design team used the same solution as that was used in the game industry. We created low polygon models with well-designed textures to simulate complex geometry. The texture of bricks, concrete, wood and grass were painted in Photoshop and mapped to the 3D geometries in 3D Studio Max.



**Figure 23: 30 faces polygon model to simulate the school in 3D Studio Max**

**Figure 24: One texture image for windows of school**

Alpha channel<sup>8</sup> maps were widely used for the texture mapping. When the experimental design team created models in 3D studio MAX, a PNG format

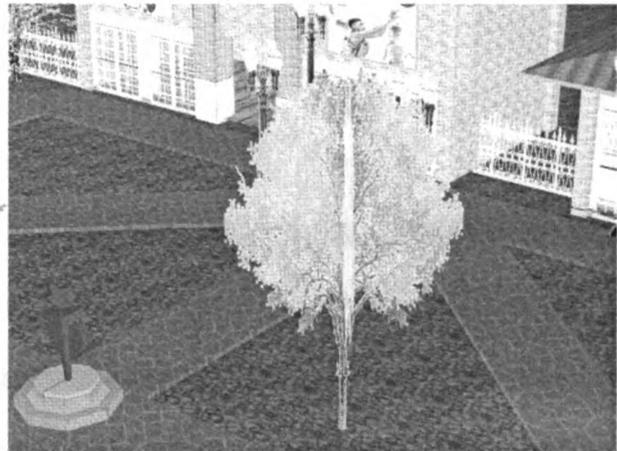
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<sup>8</sup> The alpha channel is really a mask -- it specifies how the pixel's colors should be merged with another pixel when the two are overlaid, one on top of the other.  
[http://www.webopedia.com/TERM/A/alpha\\_channel.html](http://www.webopedia.com/TERM/A/alpha_channel.html)

image with Alpha channel used as a mask texture defined the objects' visibility. For example, a 3D tree is actually a group of planes with alpha channel texture mapping on it. A series of planes were arrayed surrounding a common pivot. These plans could simulate a real 3D tree and make it looks like a real 3D geometry from different point of view.



**Figure 25: 2D PNG image.**



**Figure 26: 3D tree model in 3D Studio Max.**

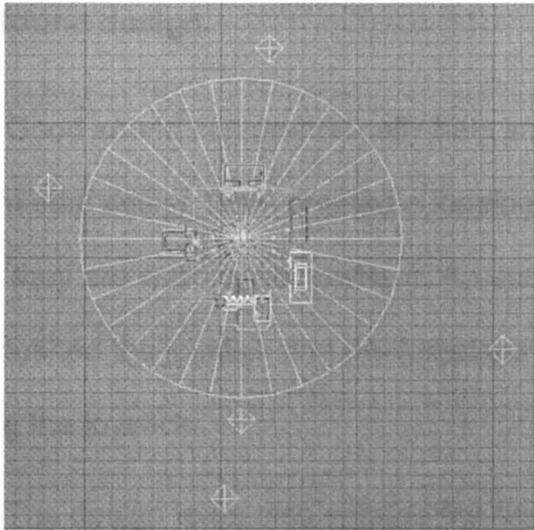
Another texture technique was the transparency texture for glass. The design team used this in creating the gym. When users got into the room and looked outside through the window, they could see the entire yard and easily sense their position relative to the other buildings.



**Figure 27: Screenshot. Look outside through the windows in Gym.**

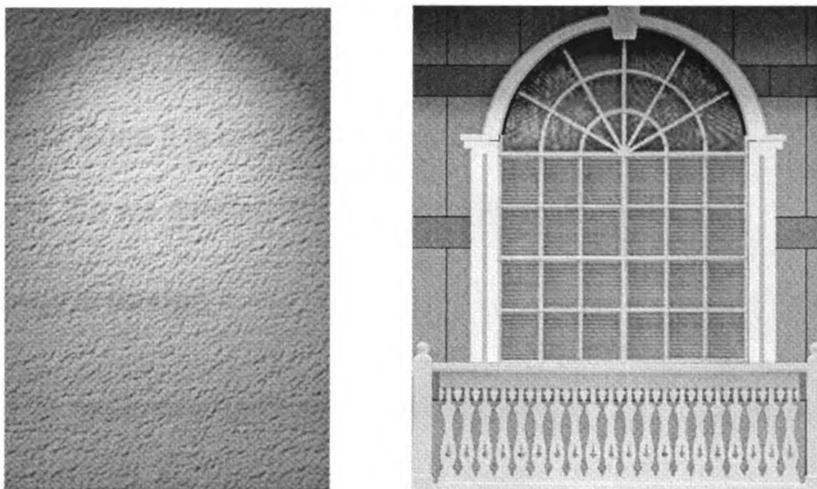
### **3.3.5 Lighting design**

Because Shockwave Director can input the light created in 3D Studio Max, the design team created the lighting environment in 3D studio Max, adjust the light intense and light color, then export the entire lighting environment into Shockwave Director. Two point lights with blue diffuse color were used to light the sky. We also used another direction light with blue diffuse color to simulate the sky ambient light. Other two point lights with lower intense value were used as fill light to put some color in the shadow. After the design team inputted the entire model with lighting environment into Shockwave Director, additional Director's ambient light was added to make the entire site brighter and more natural.



**Figure 28: Five lights' positions in top view. 3D Studio Max.**

Some of the light texture is also used to get a more photo realistic effects. This technique is very popular in 3D game design. The lights effects and shadows are painted directly in texture images instead of calculate in the real time rendering process. The shockwave engine preloaded those textures images and rendered the scene with a higher frame rate.



**Figure 29: Light effects painted in Photoshop.**

### **3.3.6 Sound design**

Good sound can dramatically help immerse users to a virtual world. The experimental design team created a looping walking sound to give the users the feeling they are walking somewhere. An audio file of footsteps was played as users pushed the joystick and the footsteps sound stopped as soon as user stop pushing the joystick.

The design team also created the background music in the prototype of spatial interface. We ran the prototype with 10 participants and collected their comments. We found all of them preferred to get information in a quiet environment instead of listening some background music, so we removed the background music in the final version of spatial interface.

We found most of the participants like the footstep sound since it is directly related with the navigation. The interactive footstep triggered by joystick is very helpful to immerse the participants with the virtual environment. On the other side, the background music is not directly related with people's real world experience since it is unusual to hear music when a person was walking in the real world. So we deleted the background music finally.

### **3.3.7 Engine design**

The experimental design team decided to use a Joystick instead of keyboard/mouse for navigation, since Joystick is a more natural navigation instrument for 3D environment than keyboard/mouse. The design team wrote the

3D engine by Lingo script in Director 8.5. The Joystick function was supported by a Director's RavJoystick Xtra. (<https://www.ravware.com/joystick.htm>)

The design team also wrote the script to support collision detection in the 3D world. Collision detection is an important issue in virtual worlds to simulate the dynamics of the real world. The camera in the 3D world should stop moving when it collides with other 3D objects. Because the camera is not treated as a 3D geometry in shockwave director, we cannot detect the collision between camera and other 3D objects. The solution is that we wrote the script to attach the camera with an invisible parent object and run the collision detection between this parent object with other 3D objects [Lingo script: see appendix 1].

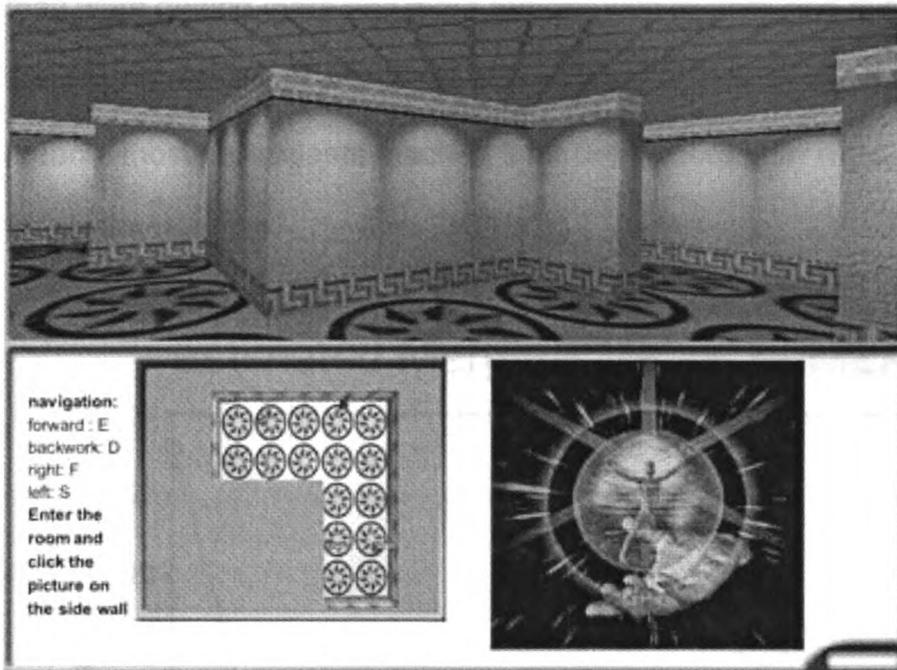
To optimize the rendering speed. The design team also used OpenGL rendering instead of Z-buffer rendering by Lingo. Computers that aren't Open GL compliant will switch back and use DirectX rendering. [Script: see appendix 2].

### **3.3.8 Training room design**

For the participants who do not have the experience of joystick, it might be frustrated for them to navigate in the virtual environment. We don't want this situation happen and affect the experiment. So, we designed a "training room" to let participants practice how to use joystick and get familiar with the 3D environment before they start the experiment.

The training room is a virtual space to let the participants get familiar with using the joystick and the rules of navigation in virtual world. It is a space where participants do some practice before they are exposed to the spatial interface.

Based on this goal, it is a relatively simpler model and smaller virtual room than the actual interface. The user could practice using the joystick to navigate in the virtual room and click the posters on the wall; they will get feedback such as how many seconds they spent walking from one poster to another poster.

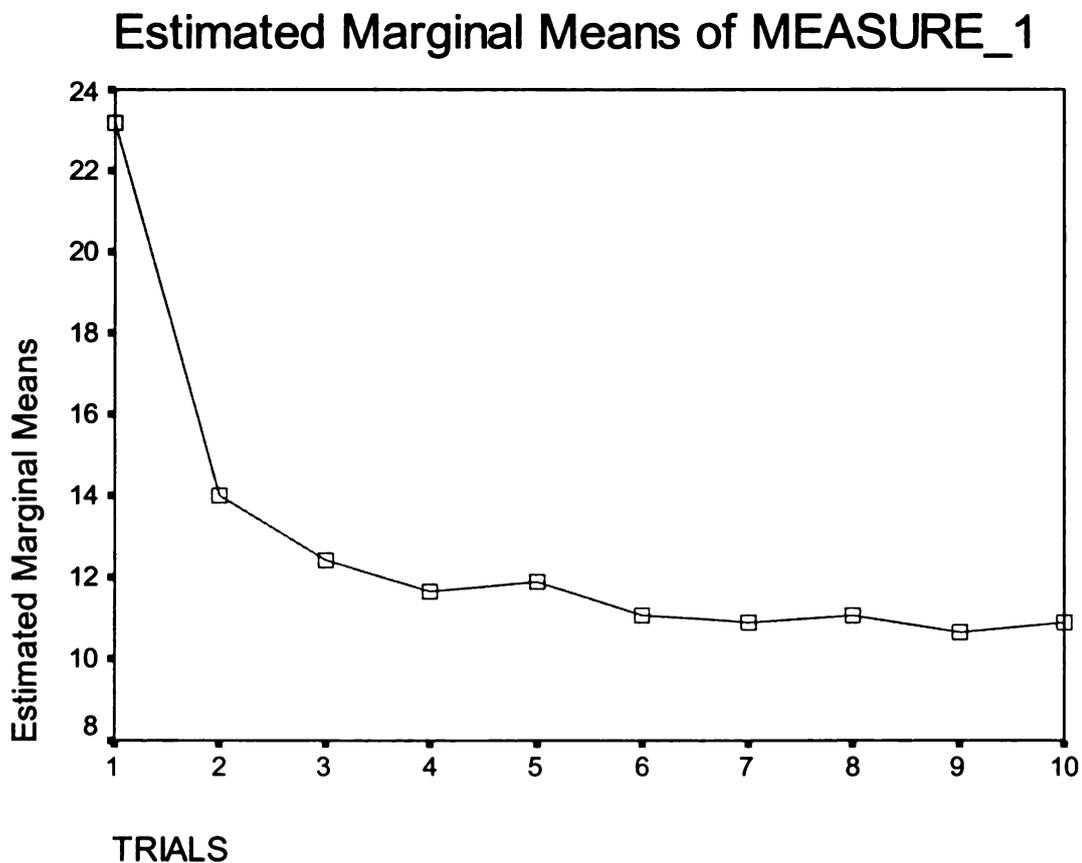


**Figure 30: Screenshot of training room.**

In the pretest in MIND Lab, 22 participants were required to use joystick in the training room. They kept navigating in this smaller space until they get enough skills for using the joystick. We designed two posters and put them at the opposite end of the training room. The participants were assigned a task, using the joystick to walk from one poster, navigate in the training room, and reach another poster. The participants were asked to repeat this task for several

times. We calculate how many seconds the participants spend to finish this task for each time.

In the pretest in MIND Lab, we found most of the participants spend less time to finish the task in the second time than in the first time. They also spend less time to finish the same task in the third time than in the second time since they were getting more and more familiar with joystick and this virtual room. But, there is no significant difference between the sixth time and later time. That means, most participants reached their best record after repeated the same task for six times.



**Figure 31: Relation of time spend (seconds) and Trials (times). Made by Weimin Mou.**

So we decided to ask all the assigned HomeNetToo participants to repeat this task in training room, walk from one poster to another one for six times. Theoretically, they will get familiar with joystick and get ready to run the final spatial experiment after this practice in the training room.

### **3.3.9 Pretest and final delivery**

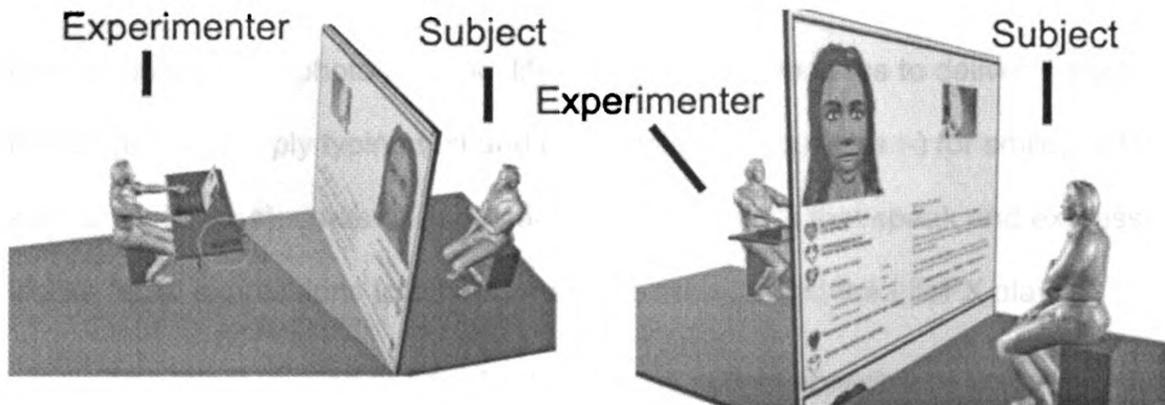
After the design team finished the spatial interface and training room, these interfaces were delivered to the experiment team who in charge of recruiting subjects and running the experiment. In the pretest in MIND lab with participants recruited from students in MSU, we evaluated their feedback and readjust our design, such as the volume of sound and fonts. Finally, the experiments were processed in Lansing and Detroit area with HomeNetToo participants.

Because my thesis is only focus the design we did as the design team for the experiments. It is not a report for the HomeNetToo experiment. All the information about the experiment, data collection and analysis is not included in my thesis. Please check these information from HomeNetToo website at [www.homenettoo.org](http://www.homenettoo.org).

## CHAPTER 4. INTERPERSONAL INTERFACE

### 4.1 Background research

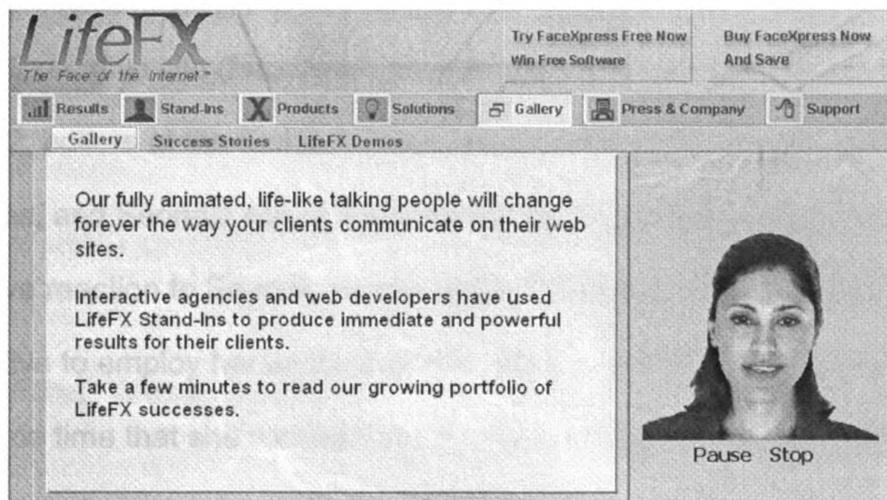
More and more web-based talking avatars are being used in E-mail, E-commerce, entertainment, multi-user games and online education. There are also many options available to design the interactivity of talking avatar. One way to make avatar interact to human speech is using voice cognition system and Artificial Intelligence (AI). There are some online products with well-designed AI, such as the official website of the movie *artificial intelligence* (<http://aimovie.warnerbros.com/>). User could communicate with the computer by typing. But there is still a long way before the well-designed AI and voice cognition product come to market. Those techniques may cost years of research and millions of dollars. Instead of waiting for those techniques, we decided to use the Wizard of Oz technique. In the Wizard of Oz technique a real person provides the intelligence missing in the programming. In the experiment, the experimenter controlled our avatar's reaction like a puppet and run our interpersonal interface experiment. So, the experimental design team can test if interpersonal interaction has a significant affect to human computer interaction (HCI) and learning process even before AI and voice cognition technique are well developed. This is a cheaper and practical way in the current situation.



**Figure 32: Experiment for interpersonal interface.**

So in order to ensure maximum accuracy for the speech recognition task and a more natural interaction, the experimental design team decided to use human to simulate the speech recognition and AI tasks. Our task was creating a talking avatar interface for this experiment. Based on this point, we studied the current available tools for making talking avatars and facial animation.

#### 4.1.1 Life FX face mail



**Figure 33: LifeFX virtual faces. <http://www.lifefx.com>**

LifeFX FaceMail is a new 3D application that surpasses plain text messages by using photo realistic, lifelike virtual human faces to deliver e-mail messages. By simply typing text and using emotions (such as :-) for smile, :-( for sad, or :-x for kiss), users of Facemail can send e-mails that speak and express lifelike facial expressions to others who have downloaded the LifeFX player.

The latest version of FaceMail also adds text-to-speech and voice recording options, giving users' "face" a voice.

#### **4.1.2 Scotland's Junior Executive Site**



**Figure 34: Virtual spokesperson: Seonaid**

As a real-time animated spokesperson, Seonaid premiered on Scotland's Junior Executive site (<http://www.scotland.gov.uk/pages/news/junior/>). Using DAT:T2, editors at the Scottish Executive type in scripts of interviews or press releases, and Seonaid would voice the words in real time. Jenny Donelan said, "Positive reaction to Seonaid on the Junior Executive site encourage the Scottish Executive to employ her on its main site ([www.scotland.gov.uk/](http://www.scotland.gov.uk/)) as well, at about the same time that she received her Scottish accent. Wherever small icons of her face appear, users may access streaming video or audio versions of announcements and new stories." [9]

Seonaid also works off-line occasionally, including a recent appearance at a museum exhibition. Jenny Donelan said, "There is no reason that in the future you couldn't access her on interactive TV, a public access kiosk system, or handheld mobile devices." [9]

### 4.1.3 Oddcast



Figure 35: Oddcast, talking avatar

SitePal (<http://www.sitepal.com>) from Oddcast Media Technologies allows users to create animated 2D characters and publish them directly to Web pages. Users design a character, select a background image, and record or select a pre-recorded message for the character to deliver, complete with lip-synching and mannerisms. Sitepal characters are based on Oddcast's Vhost technology, which enables companies to use web-based conversational characters for customer service, marketing, and other applications. I did the Homework Hotline project use SitePal when I was working in Konnech' Inc. [see appendix 4]

#### 4.1.4 Eyematic face station and shout 3D

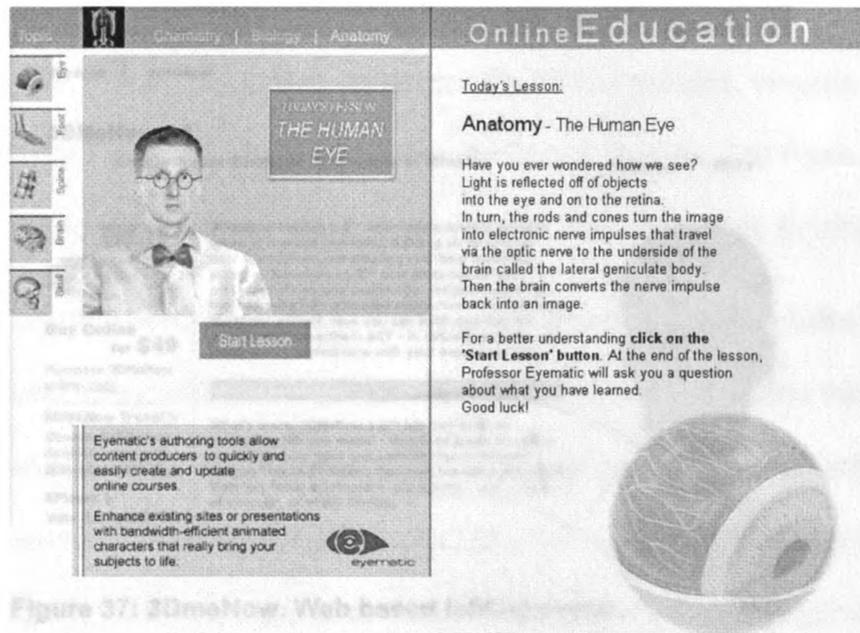
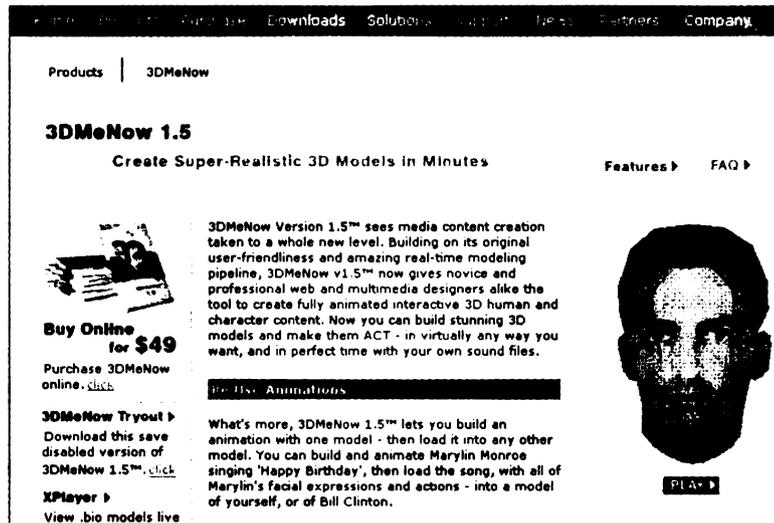


Figure 37: 3DmoNow: Web-based 3D

Figure 36: Eyematic online education. [http://www.eyematic.com/demos\\_web.html](http://www.eyematic.com/demos_web.html)

Home users and professionals can create character animation in real-time with Eyematic Face Station and publish it to the Internet. Eyematic's authoring tools allow users to publish e-greetings, personal web pages, or instant messages. This tool suite allows 3D web developers and professional animators to create highly interactive and humanized content ideal for training courses, syndicated news and product visualizations.

## 4.1.5 3D Me Now



The screenshot shows the 3DMeNow website interface. At the top is a navigation menu with links for Home, Products, Support, Downloads, Solutions, About Us, News, Partners, and Company. Below the menu, the page is titled 'Products | 3DMeNow'. The main heading is '3DMeNow 1.5' with the subtext 'Create Super-Realistic 3D Models in Minutes'. To the right of this heading are links for 'Features' and 'FAQ'. On the left side, there is a 'Buy Online for \$49' section with a 'Purchase 3DMeNow online' link. Below that is a '3DMeNow Tryout' section with a 'Download this save disabled version of 3DMeNow 1.5' link. At the bottom left is an 'XPlayer' section with a 'View .bio models live' link. The central text describes the software's capabilities, mentioning that it allows users to build and animate 3D human and character content, and that it can be used to create animations with one model. To the right of the text is a 3D rendered head of a man with a beard, with a 'PLAY' button below it.

Figure 37: 3DmeNow. Web based talking avatar.

3DMeNow v1.5™ give novice and professional web and multimedia designers the tool to create fully animated interactive 3D human and character content. Designers can build stunning 3D models and make them act - virtually any way they want, and in perfect time with their own sound files. 3DMeNow 1.5™ also lets designers build an animation with one model and load it into any other model. With Biovirtual's player, 3D talking head could be published online and opened with standard Internet browser.

## 4.1.6 Poser and Lipsinic Mimic

Curious Lab's Poser is an award winning 3D-character animation and figure design tool for artists. In January 2001, Curious Labs added the Pro Pack solution to its range of products, enabling Poser users to integrate with Maya and

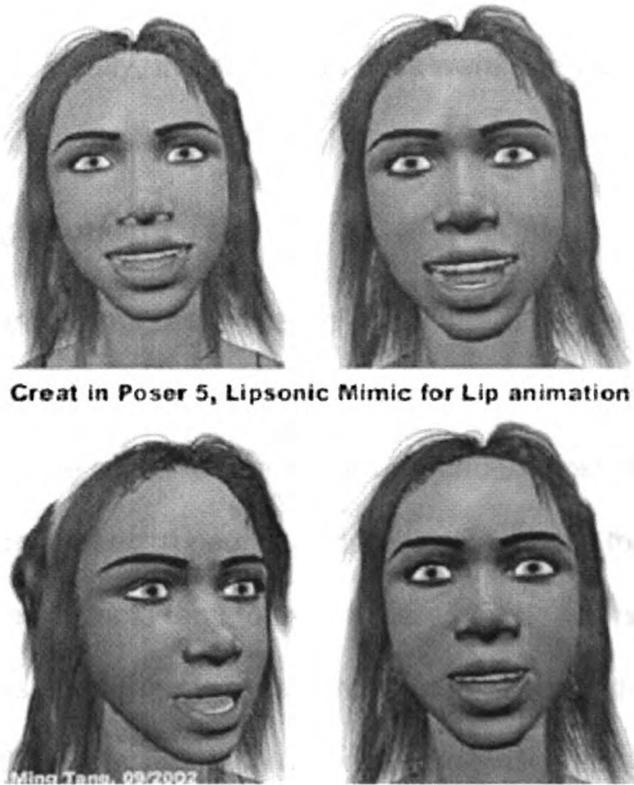
3D Studio Max. And in November 2001, Avatar Lab was released to provide animated avatars for Adobe Atmosphere.

With Poser, designers could quickly create movies, images and posed 3D figures with Poser's included libraries of human models. Pro Pack also allows designers to create and output custom animated characters to other tools.

Lipsinic Mimic is a stand-alone application for Curious Labs' Poser that automates lip-synching and facial animation. With simple voice input, Mimic analyzes speech and automatically outputs the precise corresponding mouth, jaw and lip-position data for any of the figures that come with Poser version 3 or 4, including the new Pro Pack characters. The output data generated drives morph targets to quickly and easily give Poser characters a voice. "Mimic also uses the audio file to automatically create speech gestures (e.g., head nods, eye blinks, etc.) for extremely realistic results. The technology behind Mimic is rich and complex; yet using this standalone application is very easy. Simply import a sound file, choose the frame rate, and generate an animation, which is stored directly in Poser's Pose library along with the sound file. Double click on the Mimic animated pose setting and it is applied to your Poser figure.<sup>9</sup>"

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<sup>9</sup> Curious Lab Site: <http://labreport.curiouslabs.com/article/archive/76/>



Created in Poser 5, Lipsonic Mimic for Lip animation

**Figure 38: Character rendered in Poser 5. Use Mimic for Lip animation.**

Although there are many other tools for creating a web-based talking avatar such as the tools in IMS3d (<http://www.ims3d.com/>) and OC3 entertainment (<http://www.oc3ent.com/home.htm>), the experimental design team decided to use Macromedia Director along with Poser and Mimic. One reason is that Poser's character library could save a lot of time for modeling a 3D head. Another reason is that Director's Lingo language is much easier for handling multimedia content than 3DmeNow and Eyematic's programming language. So, we used Poser's character library to create our avatar and used lip Sync Mimic to create facial animation. All the animation clips were rendered in Poser 5 and exported to Director 8.5, which facilitates the designer with more flexibility

compared with other authoring tools. Interactivity was added with Lingo language in Director. Finally, the animation clips were integrated with text, sound, and images.

## **4.2 Design concept**

Participants of the interpersonal interface were guided through the high blood pressure information by a computer-generated avatar. The avatar was present in one corner of the screen. Because most of HomeNetToo participants are African American people and “research shows that for reasons best known to themselves, people tend to trust female broadcasters more than they do males.” [9] We designed the avatar as an African American female. The research goal is to test if the social interface (interpersonal interface) is a better interface than the standard interface for learning knowledge. On the first page, the avatar will introduce herself to the participants to establish a sense of social interaction. The avatar will read the main points in the text to the participants.

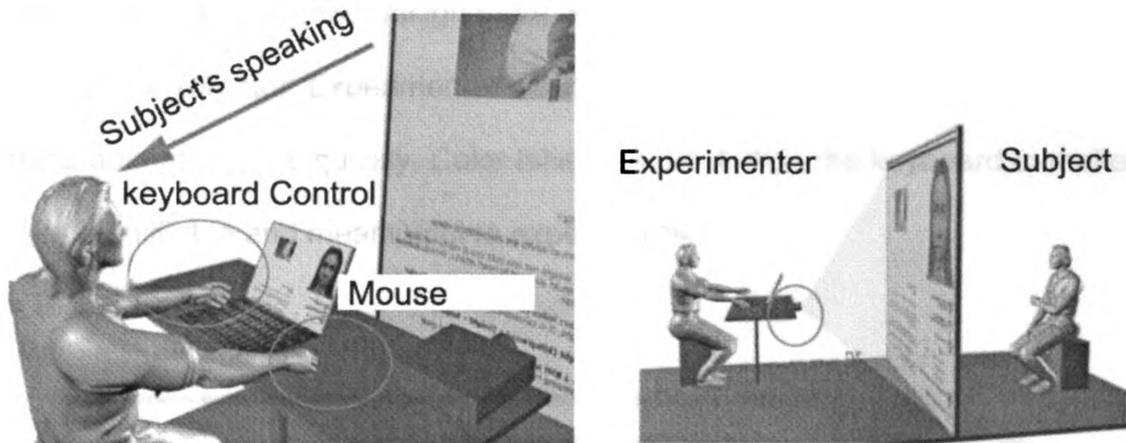
The five contents of interpersonal interface are exactly the same as the control website. (1) High Blood Pressure (HBP) effects; (2) HBP consequences; (3) HBP risks; (4) prevention HBP through diet; and (5) prevention HBP through exercise.

## **4.3 Design process**

### **4.3.1 User interface design**

The content and layout of interpersonal interface is exactly the same as the control interface except the talking avatar. Users saw the talking avatar on

the left screen as well as hearing her speak. The menu tree on the left showed the participants the entire structure of this interface and highlighted the current topic. The text and images on the right presented the information the avatar was saying. Participants wore headphones to hear and talk with this computer generated agent. First, the avatar asked participants “which content you want to go to next” each time when she finished talking about one frame. Participants made their decision and told their answers to the avatar. Then, the experimenter behind the screen operated the avatar to let her continue her teaching based on participants’ answer.



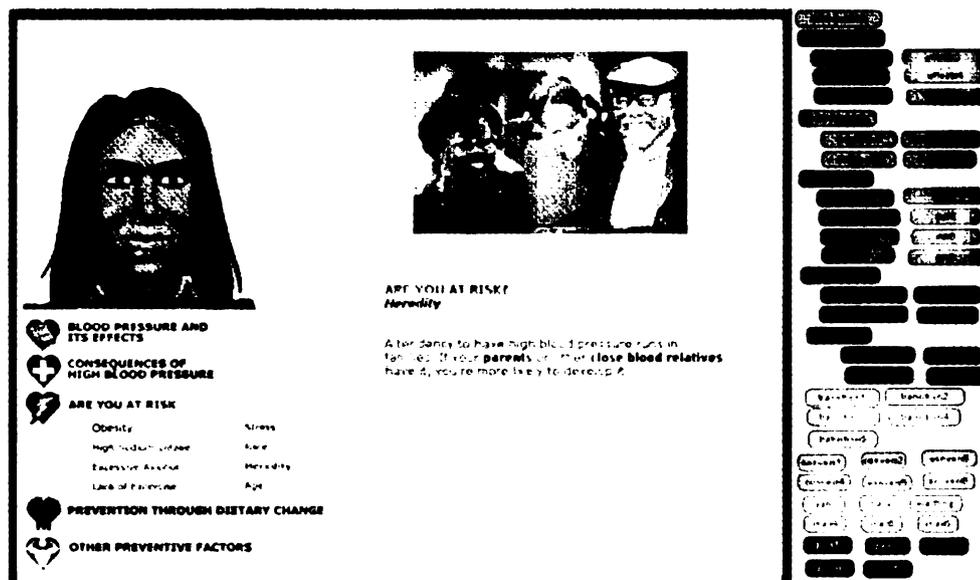
**Figure 39: Experimenter and participant (subject) in the Interpersonal interface.**

When the experimenter heard the participant’s answer, he/she used keyboard or mouse to pop up one of the avatar’s animation clips to make her react correctly to participants’ speaking. Participants could not see the

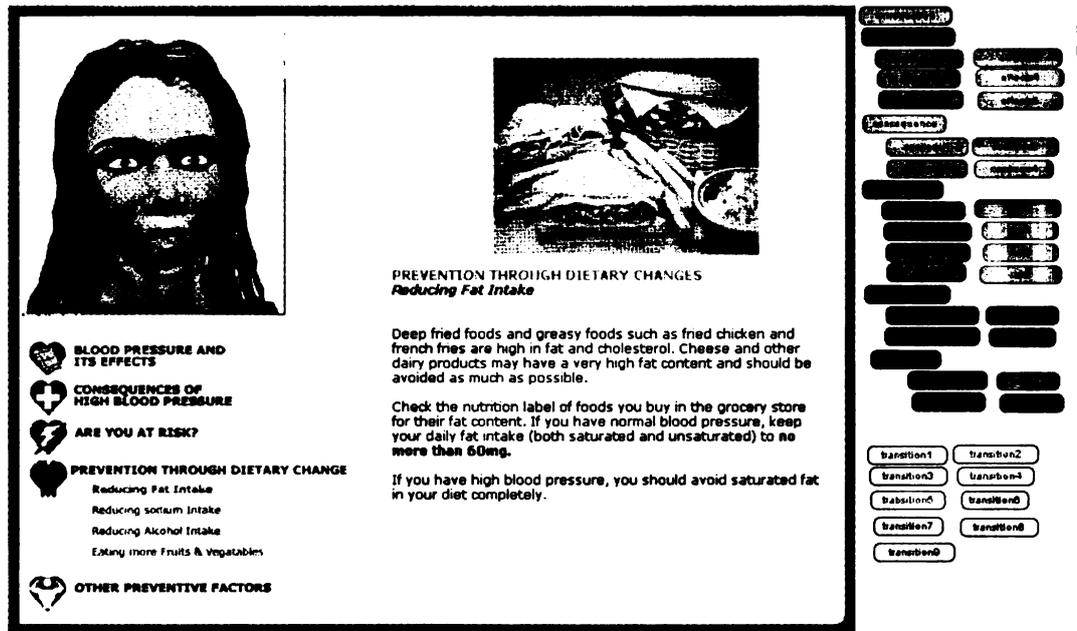
experimenters behind screen. So, they should get the feeling that they are taking with a computer generated artificial intelligent.

The resolution of the interpersonal interface is 800 X 600 pixels to match the maxim video output resolution. The experimental design team used X-video output to record the screen in the experiment. Simultaneously, we used a camera to record the participants' faces.

All the color buttons on the right side of the screen are only visible to the experimenter. The experimenter used another TV screen to monitor the entire interface. They were able to click buttons by mouse. To make the operation easier for experimenter, the design team also set up the keyboard function by Lingo script in Director. Experimenter could use pre-defined hot key to trigger avatar's animation clips quickly. Color labels are pasted on the keyboard to make the key identifiable and meaningful to experimenters.



**Figure 40: First version of interpersonal interface. Buttons on the right screen triggers all the clips.**



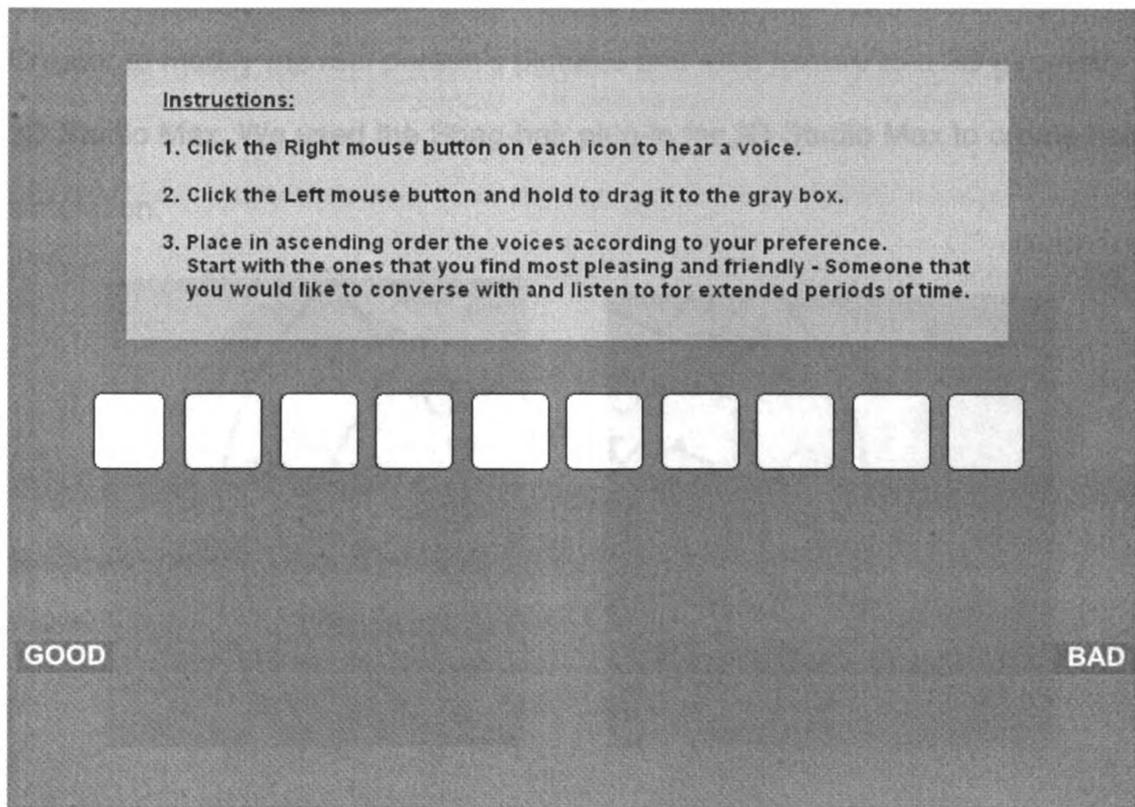
**Figure 41: Final version of interpersonal interface. Most of clips are triggered by keyboard. Less buttons on the right screen.**

### 4.3.2 Character reference

The experimental design team named this avatar as Cardia. She is African American female with a friendly face and voice. She has a good knowledge about HBP. She communicated with users and helped them to learn HBP.

The experimental design team started the character design by choosing from real people as her face and voice reference. 10 African American female were selected as candidates. We asked them to read the script wrote for Cardia and recorded their voices. We also took pictures of their front faces and side

faces. Then, the design team hired additional 23 randomly selected participants to evaluate these voices and photos. These 23 participants were asked to sort these candid 's voices and photos based on "who has the friendliest voice" and "who has the friendliest face".



**Figure 42: The interface designed for rating voice. By Lynette Lim**

Each candidate's voice was presented as a white button in the screen. Participants could click these buttons to hear the voices. They could drag and move these buttons by mouse and sort them based on their rating.

The experimental design team also printed all the candidates' front face pictures and sorted them randomly. Each participant was asked to resort these faces based on who has the friendliest face.

At last, the design team rated all the evaluations. We got Cardia's voice reference and her face reference.

#### **4.3.3 Character design**

In the beginning, the experimental design team used Eyematics Avatar Creator to modify the real person's pictures and map texture to a 3D geometry in 3D Studio Max. We used the Shag-hair plug-in for 3D Studio Max to create hair simulation.



**Figure 43: left: Real people; right: Texture created in 3D Studio Max**



**Figure 44: Cardia's head rendering images with hair in 3D Studio Max**

After using Eyematic Face Station and 3D Studio Max for modeling, the experimental design team also tried Curious Lab's character tool, Poser 5.0. This latest version of Poser also support dynamic hair simulation and ray tracing rendering for hair. Finally, the design team modified Cardia's head using Poser's character library which saved us lots of modeling work.



**Figure 45: left: Cardia made in Poser 4; right: Cardia made in Poser 5 with dynamic hair.**

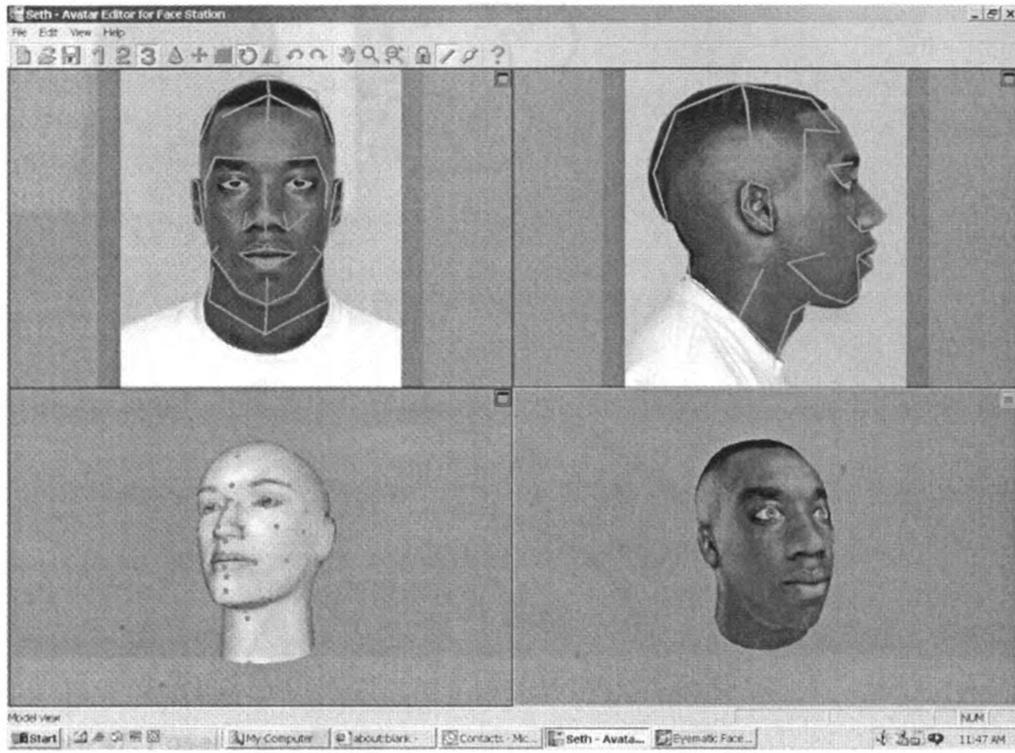
#### **4.3.4 Script design**

As the agent of interpersonal interface, Cardia read the HBP information on the screen to participants. To make a natural interpersonal communication, she needs to react to user's spoke commands naturally. Beside the script about HBP knowledge, the experimental design team also designed additional scripts such as transitions between sections, positive and affective scripts response to users' spoke commands. [Script: see appendix 3].

#### **4.3.5 Facial and Lip-sync Animation**

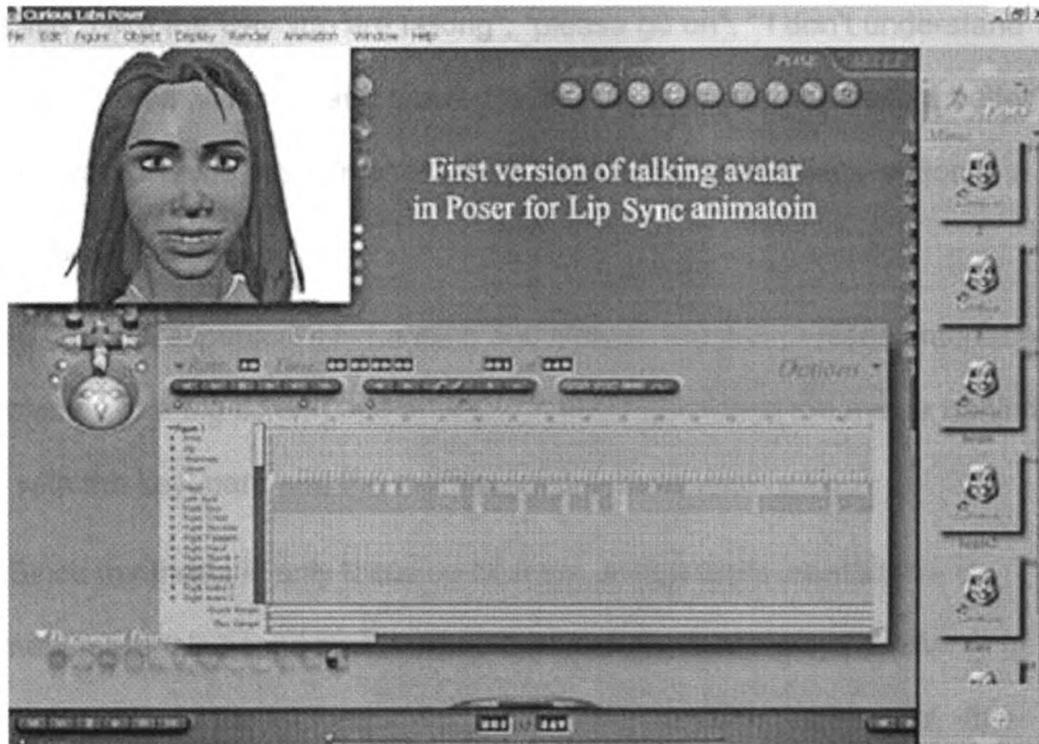
There are various ways to make facial animation and Lip-sync in CG field, such as facial motion capture, key framing animation, text-drive facial animation. We start our design with Eyematic Face Station that is a powerful package for facial motion capture. Instead of using physical markers attached on people's face (like the Vicon 8 system for full body motion capture), Eyematic Face Station use pre-recorded video clips and virtual markers to create facial motion capture data. It also supports facial motion capture though a remote video camera and trigger a morph geometry head in 3D Studio Max in the real time.

First, the design team created a 3D head in Eyematic's Avatar Creator. We shot the front and side view of Cardia's face reference and import both pictures into Eyematic Avatar Creator. Then, virtual markers are created and located to the right position on the 3D face. Finally, we used morph channel in 3D Studio Max to handle the motion capture data transferred from Eyematic.



**Figure 46: Eyematic Facial motion capture.**

The experimental design team also tried another solution: using text based facial animation tool to create Lip-sync animation. We used Curious Lab's character tool Poser to create our avatar's 3D model, then use Lip sync Mimic plug in to create facial animation. Blinking and head moving were generated randomly in Lip Sync Mimic to get natural effects. The design team finally used this solution instead of Eyematic Face station because Poser and Mimic are really easy to handle and text based animation is more practical to meet our tight schedule.



**Figure 47: Poser 5 and Mimic**

With Lip-sync Mimic, the experimental design team created 54 animation clips and rendered in Poser 5. The entire animation clips includes 30 “teaching HBP” clips and 20 “positive/affective reaction” clips.

#### **4.3.6 Pretest and final delivery**

After the design team finished the design of interpersonal interface, we delivered it to the experiment team with a basic training on how to control the talking avatar. Then, the design team and experiment team work together and made a pretest in MIND Lab.

Some MSU students were recruited as the pretest participants and gave us their feedback. After the pretest, we found Cardia should have more clips for answering the participant’s unpredictable questions. We created additional

dialogs like “I like the way you are talking”, “please go on”, “ I don’t understand your talking.”, “I am waiting.” and “yaw”. So, the experimenter will have a better flexibility and more choices to make Cardia react to the participants’ action in a natural way.

In the final experiment in Lansing and Detroit, the interpersonal interface was projected to a big screen and an experimenter controlled the avatar behind screen with the keyboard and the mouse.

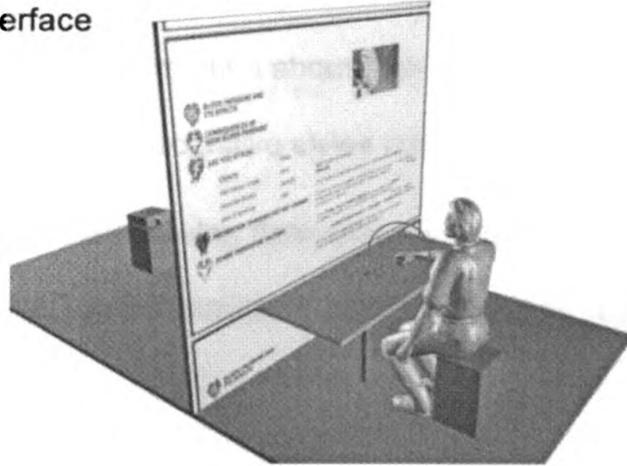
Since my thesis is only focus on how the design team created the experiment materials based on the current technology and the requirements of experiment team. All the information about the HomeNetToo experiment, data collection and analysis is not included in my thesis.

#### **4.4 Current study of HomeNetToo.**

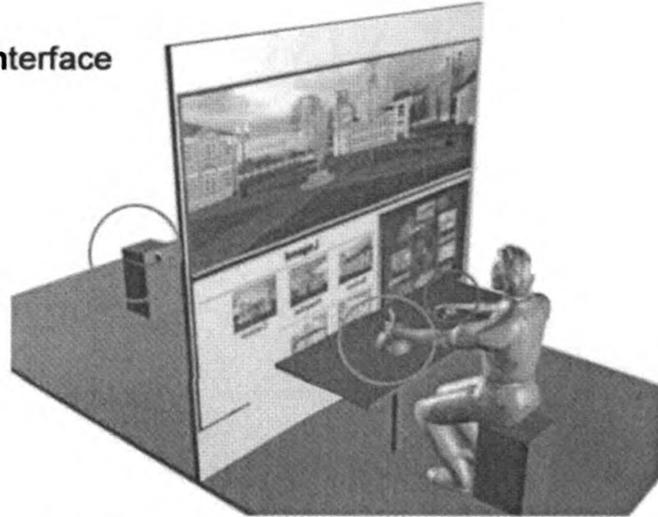
The next phase of HomeNetToo was to test participants as well as additional participants of similar demographic on the effects of different types of these three Interfaces on their ability to gain more knowledge.

117 participants from low-income communities in the Lansing and Detroit areas in Michigan were recruited for this study. Many of them had little or no prior computer experience.

**Control Interface**



**Spatial Interface**



**Interpersonal Interface**



**Figure 48: Three interfaces in the experiment.**

“Participants were randomly assigned to either a standard, spatial or interpersonal interface with information about high blood pressure and asked a series of questions to test their cognitive styles and level of knowledge gained.<sup>10</sup>”

For more information on the following data analysis, hypothesis and conclusion, please refer to HomeNetToo homepage at [www.homenettoo.org](http://www.homenettoo.org).

---

<sup>10</sup> <http://www.mindlab.org/web2/research/culture.htm>

## APPENDICES

### 1. Script of engine in Shockwave Director

Global Joystick, HasZ, HasR, HasU, HasV  
Global pMember, controllerobj, pCamera, frame\_mark

```
on beginSprite (me)
  set active3DRenderer = #openGL
  pMember = member("building4")
  pCamera = pMember.camera(1)
  mr = pMember.newModelResource("controllerobj", #sphere)
  mr.radius = 5
  controllerobj = pMember.newModel("controllerobj",mr)
  pCamera.addChild(controllerobj,#preserveParent)
end beginSprite
```

```
on exitFrame (me)
  Set X = joyGetPos (Joystick, 1)
  Set Y = joyGetPos (Joystick, 2)
```

```
  if (X>62000) then
    tList = pMember.modelsUnderRay(pCamera.worldPosition,-
pCamera.transform.xAxis,#detailed)
    if (tList.count) then
      me.checkforcollision(tList[1])
    end if
    R=1.5
    member("building4").camera(1).rotate(0, -R, 0, #self)
  end if
```

```
  if (X<38000) then
```

```

    tList =
pMember.modelsUnderRay(pCamera.worldPosition,pCamera.transform.xAxis,
#detailed)
    if (tList.count) then
        me.checkforcollision(tList[1])
    end if
    R=1.5
    member("building4").camera(1).rotate(0, R, 0, #self)
end if

if (Y>58000) then
    tList = pMember.modelsUnderRay(pCamera.worldPosition,
pCamera.transform.zAxis,#detailed)
    if (tList.count) then
        me.checkforcollision(tList[1])
    end if
    T=1
    member("building4").camera(1).translate(0, 0, T, #self)
end if

if (Y<42000) then
    tList = pMember.modelsUnderRay(pCamera.worldPosition,-
pCamera.transform.zAxis,#detailed)
    if (tList.count) then
        me.checkforcollision(tList[1])
    end if
    T=1
    member("building4").camera(1).translate(0, 0, -T, #self)
end if

if (Y<58000) and (Y>42000) then
    puppetSound 0
    if (frame_mark = 1) then
        go frame 3
    end if
end if

```

```

    end if
  end if

end control

on checkforcollision (me, thisData)

  dist = thisData.distance
  if (dist < controllerobj.resource.radius) then
    diff = controllerobj.resource.radius - dist
    tVector = thisData.isectNormal * diff
    member("building4").camera(1).translate(tVector,#world)
  end if
end checkforcollision

end

```

## **2. Script for optimize rendering**

```

on beginSprite (me)
  set active3DRenderer = #openGL

```

## **3. Script for talking avatar**

[INTRODUCTION]

Hi! My name is Cardia! I'm here to tell you all about high blood pressure. There are 5 categories in the menu below me on the left. Information will appear on the right screen. Tell me which section you would like to learn about first.

[EFFECTS]

{SUMMARY} This section explains what is blood pressure, how it is created, and who it affects.

[CONSEQUENCES]

{SUMMARY} This sections tells you some of the more serious medical outcomes if high blood pressure goes untreated.

[RISKS]

{SUMMARY} This section tells you the factors that puts you at risk or increases your risks of getting high blood pressure.

[DIET]

{Summary} This section tells you how you can control your high blood pressure by watching what you eat.

[OTHER]

{Summary} This section tells you how you can control your high blood pressure through other ways other than diet.

[TRANSITIONS]

{First few times} Tell me the name of the category you would like to know more about.

Where would you like to go next?

Which category sounds interesting?

You're now down with this section. Where to next?

You have already visited that section. Are you sure you want to view it again?

[INACTIVITY]

Loud \*yawn\*

Please go on.

I'm waiting...

What next?

Loud \*ahem\*

I can't help you if you don't talk to me!

[POSITIVE/AFFECTIVE STATEMENTS]

I like the way you're talking!

That's nice!

That's where I would've gone myself.

Okay, we do it your way.

That's the attitude

#### 4. Homework Hotline project

This is the project I did when I was working in Konnech' Inc in February 2003. It is a web based homework assignment system integrated with Konnech's PBX phone system. It was designed for Detroit Public School. I created the prototype of the interface with talking avatar generated by Oddcast's SitePal. Flash format character animation was generated to present each teacher's speaking. Students and parents could visit the homework content assigned by teachers using standard Internet browser.

URL: <http://www.konnech.com/homework>

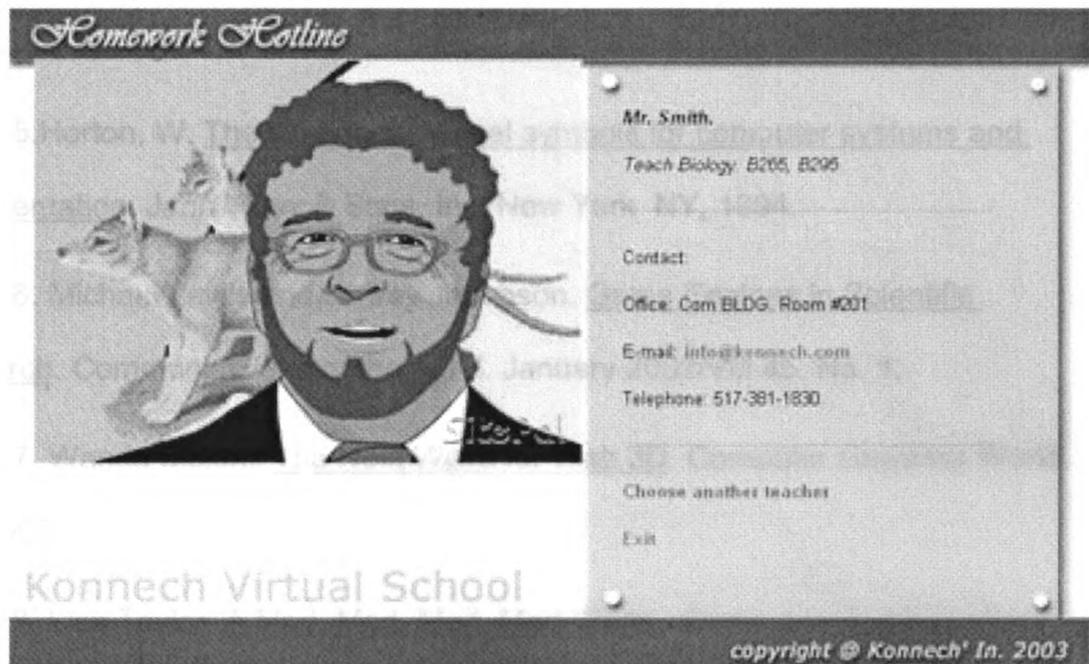


Figure 49: Virtual teacher in Homework Hotline Project.

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