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THE CHALLENGE:

DESIGNING MEANINGFUL EXPERIENCES WITH QUICKTIME VR

By

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ABSTRACT

THE CHALLENGE:
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QuickTime Virtual Reality (VR) is a multimedia technology that allows users to experience an object or geographic area "in the round" with their own mouse movements. The world wide web has accommodated ways to embed VR movies into web pages where they can be combined with other electronic media elements. This thesis explores how QuickTime VR can be coupled with intelligent information architecture and interface design to create virtual experiences, delivered globally via the world wide web. To test the implementation of this technology, a walk-through of The Michigan State University 4-H Children's Garden was created using photographs, maps, text, and interactive QuickTime VR movies. The overall experiences of the real garden and the virtual garden are compared and contrasted. Finally, the possibilities for future QuickTime VR applications are explored.

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INTRODUCTION

Pick any special place on earth. Pick a very special place, for reasons of natural wonder, educational value, or simply uniqueness. Chances are that this place attracts visitors. From Buckingham Palace to The Great Wall of China to Macinac Island: curiosity draws people to intriguing places.

The campus of Michigan State University has many attractions that draw visitors. But the 4-H Children's Garden attracted the most visitors to a non-athletic event in the 1995 season. The garden began fund raising in 1987 (the brainchild of Jane Taylor) and opened in 1993. Instantly popular, the vision and determination of Taylor prompted additional fund-raising and the garden spread from its original plot. Since opening, then there have been over 1.2 million visitors, from 150,000 to 200,000 visitors a year (and that's only during time of year it's open, about 5 months). But why are people coming from all over the world to see this garden?

The Children's Garden is not only educational, but fun. It has won numerous awards and has been hailed by critics as "the most creative half-acre in America." It is a horticultural garden -- meaning that plants are arranged for aesthetic reasons rather than purely scientific classification (as they are in a botanical garden). Plants are creatively arranged into "theme gardens." For example in the Pizza Garden, plants that are used in making Pizza are grown. In the Alice in Wonderland Maze, bushes have been sculpted into a maze and storybook character statues lurk inside. There's Peter Rabbit's Herb Garden, a Treehouse, an exact replica of Monet's Bridge, Jumping-Jet Fountains, and a Rainbow Garden for children to explore. All of the theme gardens artistically celebrate how plants are a part of our daily lives. There are over 60 theme gardens to explore!

The mission of the garden is:

> To promote an understanding of plants and the role they play in our environment and daily lives; To nurture the sense of wonder in a child's imagination and curiosity; To provide a place for the enrichment and delight of all children. (Taylor, 1996).

There is much for all ages to learn. Children may wish to climb up to the Observation Tower while adults stroll around the pond. It is place that celebrates the beauty and immersion of experiental learning. There has been interest from all over the world in the MSU Children's Garden. Curator Jane Taylor travels to one major conference per month to speak about the garden and continue fund raising. This garden is considered the prototype of its kind in North America.

The Children's Garden is a special place with near-magical qualities. But what do extraordinary places like Buckingham Palace, The Great Wall of China and Macinac Island and the Michigan 4-H Children's Garden all have in common? You must be there in order to experience them. This is the problem. How can we spread the wonder, rich learning environment, and beauty of the garden all over the world? How can the Children's Garden mission be extended to those who cannot visit firsthand? How can children in any country experience the garden year-round, even when it's buried under 3 feet of snow in Michigan? With the use of Virtual Reality delivered via the world wide web, these gaps can be bridged.

Chapter 1

THE PROBLEM: DESIGNING A VIRTUAL EXPERIENCE

VR and Subject Matter

The rich, immersive learning environments are well suited for VR applications. VR can communicate a moving sense of place, something photos and text cannot do. VR is like a moving photo, where you are holding the camera. Your movements define what you see, thus you are defining your own perception of a given area (not just dependent on the eye of the photographer). Noted VR expert Myron Krueger explains that "A traditional computer system receives input from a 'user.' An artificial reality perceives the behavior of a 'participant' in the context of a graphical world. This change in vocabulary redefines the human-computer interface" (Krueger, 1991). The VR element elevates the operator from "user" to "participant" in the children's garden. The children's garden is a self-guided tour, discovered at each visitors own pace and curiosity level. Virtual reality and webpages work well as a self-guided tour, allowing the virtual visitor to explore what interests them at their own pace.

A strength of the garden is its and spectacular sights and unique placement and grouping of certain plants in context of each other, into "theme gardens." The garden can't "come to life" on a brochure, the spirit of moving and looking around the garden is the real part of it's allure. There isn't a straight path in the garden, all walkways are decorated and lead in roundabout ways, joining back in with others all the while. This is similar in nature to non-linear hypertext navigation. You can go from point A to point B, but why not stop and look, smell, and touch some interesting plants along the way? There are no set rules of

how to explore the garden, and that characteristic can be well-communicated in a website experience with VR.

Why QuickTime VR?

The garden is a full-on sensory experience. While a VR tour through internet cannot deliver garden aromas or the feeling of a leaf texture, it can encourage a visitor to browse an area, learn about the plants at their own place, and navigate as randomly or as systematically as they wish. The VR panoramas show an explorer their surroundings in a way that gives them the reigns.

The VR technology for this project is called QuickTime VR (hereafter "QTVR"), a form of "desktop VR" developed by Apple Computers and affectionately called "VR for the rest of us." (How QTVR works is explained in Chapter 2). Unlike first-generation VR experiences, the user does not depend on supercomputers, goggles, and gloves to virtually experience a scene. Oppositely, QTVR is a desktop VR system where users navigate by clicking and dragging their mouse on a 360-degree panoramic scene (or "pano") on their monitor. But just a series of these panoramic movies isn't enough to "experience" a place virtually. A contextual information architecture is needed.

The QTVR experience needs to be designed around the ideas, the feelings, the natural state of the place the designer is trying to represent. Interface expert Brenda Laurel notes "Like every qualitatively new human capability before it, the ability to represent new worlds in which humans can learn, explore, and act will blow a hole in all our old imaginings and expectations" (Laurel, 1991). A virtual tour of a real place can be greatly enhanced by carrying the small details of the place right into the design context of where the QTVR movies are shown. In this case, a webpage. In other QTVR cases, a CD-ROM interface. Thus, it becomes not just the QTVR technology that can represent a scene, it becomes how the designer uses the QTVR movies in the larger text of a media project that will contextualize and bring to life what the QTVR movies are. A site using QTVR can be

designed on it's own terms. The place must give birth to the VR design, not the other way around. Designers can provide meaningful experiences in QTVR by carefully noting what they want to celebrate in a given scene, and designing around those themes. The QTVR must be made an integral core of the design, not a net treat added on "just because we can." But to form an experience with these tools we must understand the constraints and benefits of them.

QuickTime VR on the Web

As with any "new" technology, QTVR has advantages and disadvantages that affect a user's experience. QTVR coupled with a web browser presents a whole new subset of possibilities for a multimedia mission. This project was designed to be viewed in Netscape's Navigator 3.0 web browser (hereafter referred to as "Navigator"). To carefully craft a users experience is to be aware of the authoring tool's limitations while capitalizing on it's strengths.

QTVR and Navigator cannot provide smell, a critical element to truly visiting the children's garden. Research is being conducted at Michigan State University on how to add aromas to multimedia experiences but nothing is readily available for software developers at this time. Sound is not possible in this version of QTVR, but has been announced as a feature in an upcoming version. Sound on the web itself is still very cumbersome because of relatively slow download times, compared with the faster transfer of text and graphics. Often the garden is alive with the sound of children playing, laughter, nearby trains passing, and chimes. As a result of me choosing QTVR and Navigator as my development platform, I have lost the dynamic element of ubiquitous ambient sound.

But QTVR and Navigator as a medium has definite advantages as well. QTVR movies can playback on any computer that has the proper software (QuickTime 2.1 or later, and the QTVR player), both of which are distributed freely by Apple. There are no

supercomputers or expensive software required for use, QTVR has happily reached a consumer-level marketplace.

Perhaps the biggest advantage of QTVR is that the web browser companies have bundled their plug-ins together -- meaning any user of Navigator can easily be a user of web-delivered QTVR. This market saturation is a huge consideration. The user does not require additional playback software or special hardware adaptations. As creators of experiences, consideration of audience size is a great motivation for doing good work. The web-browsing public is a large and growing segment of personal eomputer users, and I predict that QTVR content will continue to grow in website presence.

QTVR movies have excellent photographic resolution, unlike primitive polygon worlds of early VR. The movies are made out of high-resolution photographs. This is a distinct advantage over other types of VR, which are often low resolution models (or even "wire-frame") so that super-computers can quickly process movement through them. QTVR movies, oppositely, are as clear and sharp as photography will allow. Highlighting the natural beauty was a crucial goal in creating the virtual Children's Garden, and this "photography in the round" is one of QTVR's most impressive features.

Another key consideration is that the cost of developing QTVR movies is fairly inexpensive, compared to the millions of dollars often required for immersive VR hardware and custom software. The QTVR playback software and even the Navigator web browser are freely distributed.

Approaching Creation Decisions

I approached this project as an attempt to represent a dynamic learning environment for the web. Knowing that Navigator was my final delivery platform, I was already presented with the challenge of how to make a "visual" tour of a place that would have to squeeze down the narrow pipes of the internet. Designing for web delivery presents many "beauty vs. speed" tradeoffs, and both must be considered in every decision.

I have previous web design experience and welcome the addition of QTVR to the web. This is an opportunity to combine what the web can offer well: graphical hypertext information environments, with a virtual reality element to fill the missing sense of "place." A problem plaguing current websites with QTVR is that designers are not integrating the VR element into their sense-making schemata. The QTVR movies are more like afterthoughts, hung out off the edge of the site somewhere as a "goodie" for visiting. I see QTVR as having more potential to be at the CENTER of the web experience, where the sense-making occurs. The movies must be integrated with the content of which they are representing. They can be used right alongside of text and photographs on the web to provide context, permit exploration, and aid in the user's delight in exploring the garden. They must be designed around, not added in as an afterthought!

The Mission: Designing a Meaningful Experience with QuickTime VR

Representing the Michigan 4-H Children's Garden in a webpage is difficult. It is a unique and near-magical place where the young and the young-at-heart are free to wander through the colors before them. They may go via any path they choose, stopping to see what may interest them visually. They may wish to see everything there or only a few theme gardens. They may choose to read every sign, or none of them. There are amazing things to look at everywhere, to touch, and to smell. The garden was planted to be visually as well as educationally stimulating. In short, I felt it was begging to become the basis for a multimedia project -- it was already exciting without the addition of technological novelties. I feel others not geographically close to the children's garden should be able to feel it's sense of magic, beauty, and knowledge. And if that enticed them to come visit the real garden, all the better.

Representing this place virtually would depend on looking at what makes the garden attractive to visitors - what gives the gardens it's enchanting "playful sense of place" - and trying to embody that in my web pages and QTVR. Balancing the minute detail of a

single flower pedal in full-August bloom, with the sweeping landscaping curves seen from the higher elevations presented many design options.

To represent this garden virtually, I had to use elements I could assemble myself and layout in a webpage: -- elements that would give virtual visitors the feel of the children's garden. I chose to create original graphics, textual information about the individual theme gardens, shoot original photographs, and most crucially for a sense of "place" in the garden: The QTVR movies.

Designing this virtual garden was only part of my mission, however. It had to be used. Do the virtual and real garden seem like the same place? How effective is the representation? I did very informal discussions with four friends who experienced both the virtual garden and the real garden. The talks yielded interesting feedback about how users perceive real and a virtual experience of the same place.

Chapter 2

THE TECHNOLOGY OF QUICKTIME VR

Desktop VR

The term "virtual reality" conjures up science-fiction images of high-tech goggles, gloves, and body suits. Sensors are taped to all areas of our bodies and we imagine being "fully immersed" in our virtual environment. If we're in virtual outer space, we want to feel like we're floating. If we're virtually underwater we almost expect to feel wet!

This is a highly romanticized notion of VR. Fully-immersive VR is of course very possible, though only to a select group with hundreds of thousands of dollars invested in R&D laboratories. Virtual reality in this sense has been around since the 1980's and is available only to an select few with highly sophisticated equipment. Elite VR software developers build immersive applications for an elite VR crowd (NASA Space Programs, Military weapons designers, Tele-Surgery firms) who can afford (and know how to use) the complicated equipment necessary to play it back.

But "desktop VR" is a different type of VR. Desktop VR is usually able to be developed and experienced by normal-powered desktop computers. The VR can be played back as interactive "VR movies" anywhere at anytime. Developing a desktop VR experience is also much less expensive and easier than the custom programming and on-the-fly rendering done in fully immersive VR software development.

History of QuickTime and QuickTime VR

Apple Computers developed QuickTime VR as their entry into consumer-level desktop VR development. QTVR is a subset of the larger QuickTime software architecture.

QuickTime was originally a format for time-based media (such as digital video) on Macintosh computers, but as multimedia software development exploded in the early 90's, Apple expanded QuickTime to be an integrated technology that has applications in computer music and MIDI applications, animation, capturing and editing video, and now virtual reality. Apple calls this QuickTime's "media layer" architecture. QuickTime is available for both Mac and Windows operating systems.

> QuickTime is the industry standard multimedia architecture used by software tool vendors and content creators to store, edit and play synchronized graphics, sound, video, text and music. QuickTime is the most pervasive container and playback engine for multimedia content delivered on CD-ROM and the Internet for Macintosh, Windows and other platforms. (Reeves, 1996).

QuickTime VR is system software which allows the Macintosh and Windows user to look around in three hundred sixty degree panoramas or rotate objects through their desktop computer. Users navigate space as if they were actually there, controlling their view by using the mouse, keyboard, or trackball. They can move left, right, up, down, and zoom in and out. QTVR files are called "movies."

When QTVR is embedded into other multimedia platforms (such as HyperCard, Macromedia Director, or Apple Media Tool), it can also take advantage of other features, such as information spots within a panorama where the cursor icon may change from an arrow into a document icon. Clicking when the cursor is a document brings up textual information about what place, object, or person is being selected.

Panoramic Movies and Object Movies

The two main types of QTVR movies are very different. Panoramic VR scenes are a picture in the round, 360 degrees (or less) can be viewed by the user as if they were standing in the middle of the scene. Object vr movies, oppositely, give the user the experience of being outside an object, such as a vase, and looking in at it from any angle.

Users may virtually rotate these objects to see it from any particular direction. If the object is larger, such as a car or a statue, the vr experience is as if the user is walking around it, to see from any angle on the perimeter of an outlying circle.

Panoramic movies can be linked together using a "scene editor" into "multi-node" VR movies, where a user can look around inside a scene (or "node"), and then advance to other adjacent nodes. Finally, object movies and panoramic movies can also be linked together. For example, a user may be in a panoramic scene of a living room and move your mouse across a vase. If the vase is it's own object movie, you can "pick it up" and move it around to get a closer look. Users can also zoom in and out of a scene by using two keys on the keyboard while they point with the mouse. Between panoramic movies and object movies, QTVR is very effective for making walk-throughs.

How Does QuickTime VR Actually Work?

In order to discuss the creation of QuickTime VR scenes, first the concepts of how QTVR technology "works" must be understood. QuickTime VR makes virtual scenes from actual still images. Scenes may also be modeled in 3-D software programs and rendered as still images to use instead of photographs in QTVR.

Panoramas are often made from photographs because they provide the most accurate images and can be digitally archived onto high resolution Photo CDs. They can also be made from captured video stills, though the resolution will only be as good as the video source, (which is typically worse than photographs).

To photograph a QTVR scene, a photographer mounts a camera with a wide-angle lens on a tripod. The tripod head has a special rotational device that allows the rotation of the camera at pre-determined increments so that each photo overlaps the previous one. The film is digitized and the images are digitized on a Photo CD.

The images are then processed with a software program that "stitches" the many individual stills together in such a way as to create one long panorama image: a continuous

blend of all the photos. This panorama is mapped onto the inside of a cylinder, which creates a warping effect. But on playback inside the QTVR player, the distortion is corrected by a special algorithm and the image is un-warped as the users pans left, right, up, or down. The QTVR playback software keeps up with the user's movements "on the fly," showing the optically corrected panoramic movie.

Creating QuickTime VR, Equipment Needed

The process begins by capturing images. A single-lens-reflex 35mm camera is recommended for the highest resolution, though Apple's QuickTake 150 digital camera works as well (the resolution and lighting will suffer somewhat). For high-resolution QTVR movies that detail during zooms, 35mm film and Photo CD format is recommended. The QTVR movies taken with a QuickTake 150 have reduced image quality when users zoom in more than 50%. An advantage of the QuickTake, however, is that there is no scanning or Photo CD's to be made once the images are taken, they can simply be downloaded onto a nearby computer. This is a very convenient process which saves time as well as the cost of Photo CD processing.

Just as important as the camera is the tripod head that rotates the camera 360 degrees while shooting. The series of overlapping still images are later digitally "stitched" to make one very long picture. Thus, the uniformity of how these images are shot is crucial to the finished product looking seamless. A tripod head specifically engineered for QTVR - with it's levels and rotational degree markings - assures this uniformity.

Because of the peculiar stitching process done to the images to create VR movies, the focal point of the camera must remain in the exact center while the camera rotates. If not, an un-natural wrapping look will detract from your final panorama. Not only does the camera have to be exactly level horizontally, but it's focal point must be centered exactly over the panning axis. The special QTVR tripod head accommodates this. I used the

QuickTake 150 digital camera and the Kaidan tripod head made especially for it. (This is also the least expensive QTVR setup).

Software Needed

There are 2 free tools available from Apple for developing QTVR movies, though they are very basic (beta versions) and crude compared to what you can do with the real development kit. The free utilities are Make QTVR Object 1.0b3 and Make QTVR Panorama 1.0b4. These tools are meant to be a taster to what can be done with the real QTVR developers kit. These tools are limited and not even recommended for use with multi-node QTVR projects.

For serious development, the QuickTime VR Authoring Tools Suite 1.0 is recommended, which also includes MPW Pro. The tools suite includes all of the capabilities of the free beta-level tools but much greater flexibility and fine-tuning. With this software, separate photos are stitched together to create a 360 degree panorama. "Hotspots" can be added to panoramas that trigger actions.

DeBabelizer is another useful piece of software for batch-processing images. This automates the process of reducing the source images to half-size for easier stitching, if desired.

Hardware needs are pretty extreme as well. MPW-Pro acts like a giant Photoshop when it processes all the images and stitches them together into a enormous cylindrical PIC file, then re-sizes and sharpens it. These are all extremely memory-intensive operations. I processed my VR movies on a Power Macintosh 8100/120 with 60mb of RAM.

Shooting The Images

Because the QuickTake only stores 16 images at once,the tripod head was configured to overlap each picture at 16 clicks around, to equal 360 degrees. Depending on how many pictures are needed to take for a full panorama, the degree marker on the tripod

head is adjusted accordingly. This setup allows the pictures overlap enough to be stitched. A 30% overlap from shot to shot is recommended, though this varies. The tripod must be completely level. There is a small circular bubble-level on the top of the head, and looking down at that was the best way possible. Better tripod heads have two horizontal levels that cross each other, which is more accurate for true leveling. If the shots are not level, when stitched they will appear to wobble up and down as the user moves horizontally across the QTVR panoramic movie.

Once the leveling step is complete, The QuickTake's memory is cleared. Then the surrounding area should be surveyed to see if moving people or cars could potentially interfere with the shots. Another crucial thing to watch for is changing light patterns. Shooting in sunlight on a clear day makes for a much more even exposure - on a clear day.

Shooting panoramas on a partly-cloudy day can be very problematic. Partly cloudy days are difficult because once you start shooting in the round, if the sun goes behind a cloud or suddenly becomes brighter, the light exposure will differ from one shot to another. When stitching the images together, this will create a blurred line from a darker image to a lighter one. The goal of stitching is for the many images to combine like one extremely long picture. If there is "banding" from shot to shot depending on lighting, and this ruins the seamless effect.

Sixteen shots with the QuickTake 150 (one for each click on the tripod head) will complete the panoramic shot for that node. Once the QuickTake's memory was full -- containing just enough images for a full panorama -- it was connected to a Powerbook and the shots are immediately downloaded onto the hard drive. This process is repeated for every node.

The QuickTake Image Access software on the Powerbook is very simple to use. It acts as a control panel which mounts the camera (like it would an external hard drive) and puts a camera icon on the desktop. The images are downloaded out of the camera just like a file server, the data travels through a serial cable. Once the download is complete, the cable

is disconnected from the camera. The Image Access software builds thumbnail icons for each image.

Processing The Images into VR

The images are transferred the images from the Powerbook into the Power Macintosh 8500. There are three things to do to the images at this point:

1. Stitch them a single, long panoramic picture
2. Dice this big picture into frames that form a QuickTime movie
3. Transform this diced QuickTime movie into a QuickTime VR movie that the playback device can read.

After trying unsuccessfully to stitch the full-size (640x480) images together (40mb was not enough RAM) I used Debabelizer to shrink the batch of images to half size, so each image was 320x240. The stitcher was able to handle this size. The "stitch" command is used by the MPW-Pro shell software to overlap all the images at their seams and blend them into one long panoramic picture. First the stitcher lines up the first two images and calculates roughly what adjustments are necessary to stitch these first two images successfully. Then the rest of the images are stitched based on this initial calculation process.

Through a systemic trial and error process - documentation is cryptic at best - I developed a script that worked well for my size images. There are many variables to tweak depending on the many input values for various stitching controls. Getting just the right script took many weeks of debugging tests and often the machine crashed if it ran out of memory in the middle of a script execution. Debugging became a meticulous process of looking at the processing output script for clues of what values needed to be changed for a successful stitch. This output is generated with the "-verbose" command is included.

Notice in the script below, MPW-Pro needs to access the files on the hard drive in folders, to all directory paths must be correct. My final script looks like this:

```
########doing same triple-process for N-Node (N- south door Union)
########change node letters to "N"
########
########stitching
stitch -fovy 27 7 -files 00-15 -rotate 90  -offset 180 0 ¶
-range 50 10  -wrap  -cropOut  -sharpen  -blend  -fill ¶
-show  -dir "A/V WORKSTATION:QuickTake pix 5/11:N- south door
Union" ¶
-out "A/V WORKSTATION:Matt output:N-Node" ¶
-outHeight 3000  -outWidth 240  -verbose -cyldim 500 4000 ¶

########dicing
p2mv 1 24 "A/V WORKSTATION:Matt output:N-Node.mov" ¶
-in "A/V WORKSTATION:Matt output:N-Node"  ¶
-codec "cvid" ¶

########makes it QTVR movie
msnm "A/V WORKSTATION:Matt output:N-Node.srcmov"  ¶ -source
"A/V WORKSTATION:Matt output:N-Node.mov" 1 24 ¶
-windowSize 320 200  -vPanRange 14.5 -14.5 ¶
```

Each command represents a variable or filename. The three commands, stitch, p2mv (dice), and msnm (makes it a QTVR document) can be executed together as long as each command finds the files it needs in the correct directory path. All three of these commands required about 7 minutes of processing time for the Power Macintosh 8100. A stitched pict looks like this, but the actual size is over 3000 pixels long.

The procedure described is for creating what is called a single node movie. A multi-node movie is created by linking two or more single nodes together using a software tool called the Scene Editor. It is a Hypercard stack that you duplicate a "virgin" copy of and then plug your files into. Like MPW-Pro, various files need to be put (with appropriate file extensions) in pre-named folders. In the Hypercard interface, nodes are dragged around a screen (a makeshift map of your site) and the nodes pop up as QTVR movies in two windows. Then in a squished thumbnail version of your long panoramic pict, "hotspots" are defined with a marquee. Once a hotspot area is defined, the "link from" and "link to" parameters are specified.

There are various parameters to enter at all stages, such data about the VR movies and amount of desired zoom when changing nodes. This is a crude software tool, it's interface is marginally better that MPW-Pro, which has no interface to speak of. At least in some ways there are buttons and menus to achieve a given task. The result of the linking process is the export of several PICT resources and a work sheet script that is fed back into MPW-Pro. Thus, the scene editor does not even link the nodes, it just generates a set of parameters and resources that MPW-Pro needs to link the movies. The appropriate script is executed in MPW-Pro and, using data from the Scene Editor along with the exported PICT resources, the final multi-node movie is created.

The QuickTime VR movies can stand alone (opened with QTVR Movie Player), or be imbedded in various multimedia authoring tools, such as MacroMedia Director, Apple Media Tool, or Hypercard. They can also be served on the Web.

QuickTime VR Takes to the World Wide Web

The movement of QTVR to the web is a significant development for it's spread and acceptance in the multimedia field. On April 30, 1996 Apple and Netscape Communications Corporation made a licensing agreement that every Navigator 3.0 web browser would include a QuickTime plug-in, which has increased the use of multimedia, video-based images, and digital music on the world wide web. Apple also made available a QTVR extension to this plug-in that enables users to view 360-degree virtual environments withing their web browser window, ("in line" QTVR movies) that don't have to launch an external helper application. The plug-in enabled a common design center for both multimedia authoring and playback, a new standard for internet delivered sound and video. (O'Connell, 1996)

This was an exciting announcement for QTVR developers. Now they had a fast, global forum to distribute and create multimedia using QTVR. Websites could include QTVR easily and because file sizes are relatively small (usually. between 100-700k) even

download times wouldn't be bad. Getting QTVR movies to play in webpage browsers could create a new way to design, since the panoramic movie is a dynamic element within the webpage, not isolated off on your desktop, separated from it's context.

To embed QuickTime VR movies in a webpage, only minimal adjustments are necessary. The QTVR movie must be opened in it's player and saved as a "self-contained movie" (playable on non-Apple computers). Finally, to reference the QTVR movie in a webpage, simply use the "embed" command, the HTML syntax looks like this:

<EMBED; SRC="SampleQTVR.mov" HEIGHT=200 WIDTH=320>

Replace the name "SampleQTVR.mov" with the name of your movie, and the values for height and width of the movie with the dimensions of your movie.

Chapter 3

SURVEY OF OTHER DESIGNS USING QUICKTIME VR

Integration with QuickTime VR

With the forging QTVR movies completed, what do we do with them? That they merely exist is not to say that they can enrich a multimedia experience unless they are used properly. QTVR movies at their core are just another media type, (like text, graphics, and sound), to now be utilized and assembled with other information to create an experience. How they are placed and combined with these other elements is what will create the "wholeness" of an experience and take full advantage of their engaging nature.

A single-node QTVR movie is visually stunning and fun to use the first time, but how it is combined with other elements in the larger software interface can greatly strengthen an experience or message. The virtual tour of the children's garden is about communicating the essence of a special place. QTVR sends a strong visual message, unique because the user is in control of what they are seeing (unlike almost any other form of visual telecommunication). Crafting a useful (and fun!) interface around the QTVR movies was crucial to the "virtual realness" of the garden website.

Interface design is a relatively new field, compared to the pursuit of making software that it is associated with. Alan Kay, a recognized expert in the discipline, reminds software developers that:

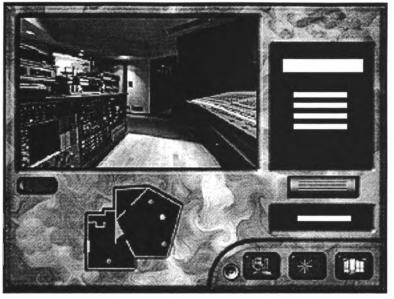
> Many are just now discovering that user interface is not a sandwich spread -- applying the Macintosh style to poorly designed machines is like trying to but Béarnaise sauce on a hotdog. (Kay, 1992).

Good user interfaces are planned out in accordance with subject matter; the information architecture, users, and communication objectives should determine the "look and feel." I felt that studying how designers were incorporating QTVR into their software was an important issue to research before I created my own. I looked at numerous examples and analyzed in detail the function of QTVR in interfaces in 4 products: 2 interactive CD-ROMs and 2 websites. All 4 of which I found to be, in spite of my criticisms, the best of the lot.

Prestige Studios of The World (CD-ROM) Critique

Prestige Studios of the World is an promotional CD-ROM that showcases the finest audio studios from around the world. Using QTVR, the authors modeled a fictional building and central portal (called the "Terminus") where a click on one of 10 doors transported the user to any one of 10 famous recording studios, from all parts of the world. This is indeed a novel idea for those interested in recording studios. From one place they can tour the finest studios, look around themselves using QTVR, listen to tracks recorded there, and read informative text about it.

The interface is fairly easy to understand. There is a control window with several recessed areas, each serving a specific purpose. In a large window at the top, the QTVR movie plays. Below that space is a map of the studio you are presently in, with dots representing different QTVR nodes. (Some form of map with dots to show node placement is prevalent in many QTVR products). There are areas on the right to show text. A rotational cylinder beneath the text window toggles what text is shown there: equipment, staff, clients, etc. There is a small info-window near the corner that offers instructions to the user depending on whatever their mouse rolls over.



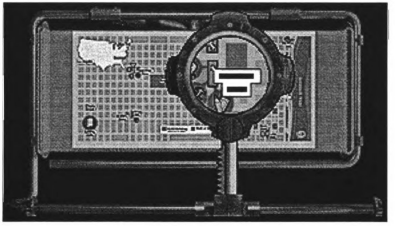
The use of QTVR to create a "studio presence" in this product is impressive. Even the transitions between some QTVR movies are animated in a 3-D modeling program, for a seamless transition from the Terminus hub to the selected studio. The studios themselves are composed of multi-node linked QTVR movies, allowing the user to access multiple VR movies from within the same window. If they wish, they can also navigate by clicking on the nodes in the map below.

Overall the QTVR content is well-integrated with the other media available, (such as info about the studio, tracks playing in the background that were recorded there), and moving from pano to pano within the QTVR movies is nice. The whole concept is well-thought out to take advantage of the media types, and touring the studios via QTVR is a much stronger experience than just photos, as you can choose what you wish to see in each studio.

Design drawbacks include a distracting terminal background (marble??), an ugly overall pop-up map that looks like an afterthought (different from the excellent node maps of each studio), and a few vague icons. Despite these few formal elements, the authors use of QTVR to provide an experience is very well done.

Savannah College of Art and Design (CD-ROM) Critique

This product has a broader goal to give interested students a wealth of information about the college, including curriculum descriptions, admissions information, and interviews with students and faculty. Most innovative, though, is the use of QTVR "invention" to navigate a virtual tour of the campus. By selecting "campus tour" on a rotational subject wheel, two mechanical devices appear on the left of the screen. Looking like 1930's era science-fiction devices (reminiscent of Terry Gilliam's vintage technologies in the film "Brazil"), these devices control what QTVR movie you are seeing. The top device unfolds from the center to create a "tele-screen" where the selected QTVR movie will play. Below this player is a device that magnifies a map beneath it.



The user grabs this device with the mouse and drags it across the map, and can stop on any labeled area. To see that labeled area in QTVR, they simply click it inside the magnifying area. This eliminates the need for multiple large overall maps, a single map can be used because the magnifying glass provides enough detail to make a selection.

Once a QTVR node is selected, the magnifying glass folds down (now out of the way) and the general map of the campus is replaced with a specific map of the nodes in that selected building. The QTVR nodes are again shown as dots (similar to the interface in the

Prestige Studios CD-ROM) where any dot can be selected to jump to that panorama. Users may also click through the multi-node movies in the "tele-screen" window above. The feedback of clicking through the movies above and seeing the selection change below is a user-rewarding system that works well when the jumps between individual nodes are drastic. On the left, once a building has been selected, a scrolling text field appears and provides information about the area being virtually explored.

This implementation of QTVR with content is clean, functional, and utterly ingenious. The magnifying device to select a spot is cute, fun to use, and completely useful. The navigation within the panoramas is also easy. This experience, even in it's other non-QTVR sections, is beautifully designed around its content. There is much to be learned from their creation of imaginary "information tools" like the rotating wheel, video and QTVR "tele-screen." The formal elements of the page all work well together, the design is consistent and elegantly simple.

QuickTime VR From CD-ROMs to the Web

With great CD-ROMS like these, creating QTVR on the web is a tough act to follow. There are many issues to be weighed, but most notably, designing websites using QTVR are subject to extreme bandwidth limitations. CD-ROMS development is unfettered by data-rates, modem speeds, and graphic sizes. But all of these are concerns for webbed VR development and design. Taking VR to the web can create immediate global access for those connected, something CD-ROMs cannot do. Creating virtual experiences for the web thus requires designers to choose their media elements very carefully for optimum effect while keeping the bandwidth requirements as low as possible. I will comment on two websites that I feel have taken progressive steps forward with the use of QTVR in their websites.

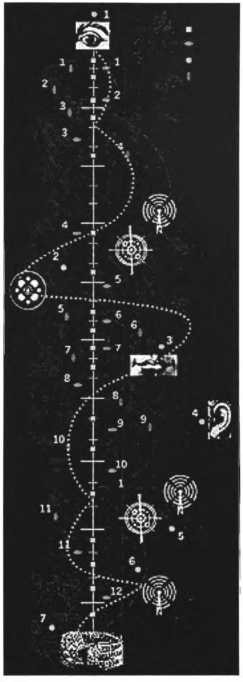
Virtual Metropolis (Website) Critique

Virtual Metropolis is an ambitious project to say the least. The project features a virtual model of a section of Toronto. The model combines a "real" above the street tour with a "hidden" cities underground accessible through manholes. In the creator's own words:

> "Virtual Metropolis" is a think-tank of progressive urbanism: it's mission is to make visible the multi-layered culture of the contemporary, wired city. Here, architecture and urbanism provide the code to access a series of passages to the city's alter-egos. Created by artists, architects, and designers, these "fictive" cities reflect back the real city, the city of our daily existence, to its present inhabitants and future visitors. The city, in turn, gives structure and coherence to the experience of the virtual and cultural world. (Oulette, 1996).

The site begins with a large map of John Street in Toronto.

The map is misleading, however. It has colored labels above it that leads the user to believe they are clicking on a specific part or node, when in fact the whole image is takes you to the same destination, another un-labeled map.



This map is a composite of the four cross-cutting ways to experience a virtual John Street. There are four colors of dots, each one is numbered (but the numbers are never seen again after the initial map, making them meaningless). Each dot stands for a different type of VR node: Other "Streets" that cross John Street, "Sites" above ground, "Cities" (fictional) below, and by the "Artists" who created some of the original work. You can also see these

maps separately, though none of them are labeled in any way. Unfortunately this renders the individual maps just as ambiguous as the composite map. The content of this site may be considered experimental and experiental and highly artistic, thus perhaps the creator wishes the user to wander the city without knowing where they are going. If that is not the intent, the cross-cutting methods are very confusing.

Despite it's navigational problems, the use of QTVR to create a real city as well as fictional cities (such as the "city of tides", "the forgotten city", "the city of satellites", etc.) is a revolutionary and creative concept.

The "Sites" VR nodes are a great way to travel down John Street. Though they are single-node movies (often necessary to keep the files small enough for web traffic), from each node there are usually hotlinks to adjacent nodes. Unfortunately, once you visit a node (any of the 4 varieties) you have no way of telling on the main map what nodes you visited or not, and since they are not labeled you may accidentally pick the same node twice -- this is annoying.

As far as the treatment of VR within the interface, the VR movie size is kept appropriately small, so the downloading is fast. But the movies either launch as a separate media item (used by Navigator) and are detached from the content, or if they do play "in line" the movies are devoid of contextual information. In fact, to remember what they are looking at, users must use the "back" arrow. The most serious problem with most of the QTVR content currently on the web is that the VR is not integrated with what it is representing.

The greatest strength of this experience are the artists' QTVR nodes of the fictional cities. These VR movies are not photographic as the above ground ones are, but instead are artistic models or 360-degree collages of artists material. They create a very different feeling than the "realistic" QTVR movies and the departure leaves the user draw their own meanings from the combination of the title and the images. These artists' VR panoramas stand well on their own as exploratory devices, the random method for choosing them suits

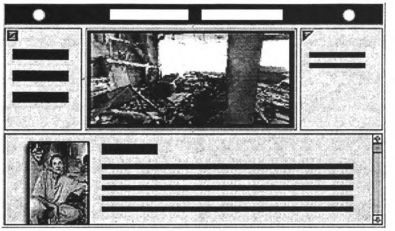
well to their arty (even spooky) feel. They do bring in a very voyeuristic element to the "underside" of the city, as they are represented as manholes on the street from above. This attempt to combine the two worlds is a great step forward for what can be done with QTVR to create a multi-faceted experience. Unfortunately the web design and navigation suffers and the message is somewhat scrambled along the way.

Witness: Roads to refuge (Website) Critique

This website one of the many online projects from World Media Live in France. "Witness" is the name for their online documentary series. This particular series is called "Road to Refuge", an original documentary that presents first-person accounts of the issues and events around the war in Bosnia. The site makes unprecedented use of QTVR photography, enabling the user to "enter" and explore each documentary setting. The "Witness" series is a turning point in online journalism and their use of QTVR integrated with storytelling is outstanding. This documentary story concentrates on:

> the plight of Bosnia's uprooted population — the civilians targeted because of their ethnic origin or because of where they happened to live. "Roads to Refuge" presents the stories of some of those who survived as they attempt to put their lives back together and find their way home. (Matoso, 1996).

The site uses Navigator's "frames" feature, which divides the web browser window up into 5 (sometimes 6) separate html documents. The middle frame is where the QTVR movies are shown, thus (using the "embed" html command) anchoring them directly into the webpage, not launching them off with a "helper application" or putting them alone on a separate page. Already this is an advantage over the previously examined website example.



This is a very appropriate method for their content, which tells stories about the war refugees below and shows still photos as well. From the body copy of the story, the user can select to "enter the QTVR scene" and a pano will load in the center window. Because the subject matter is so heavy, this method is extremely effective for creating an virtual experience. Users may virtually look around in side war-ravaged deserted apartments, or walk on soldier-lined streets. These panoramas seem very real, and by choosing where to look the user experiences looking through the destruction firsthand. Combined with audio excerpts and text from interviews, "Roads to Refuge" successfully uses QTVR to tell a very moving story.

The window on the left of the pano provides overview sections: "contents", "site index", "help & tips", and a "credits." The purpose of the window on the right is less clear, it is for additional information when reading in the body copy of the story in the lower frame. A criticism can be made of the way they have arrows up and down and jumps up and down within the text of the story. I feel that one scrolling story (for each of the 7 sections) with pictures and sound bites would be better than chopping them all up and having the user figure out their arrow system, different from the given vertical scrolling arrows in Navigator). Doing the design with less frames would have created less inter-site

confusion. They could have laid out the same information with 2 or 3 well-designed frames rather than the 5 and 6 they use (plus launching external windows for maps!).

Overall, however, the mission of the site is executed very well and it is perfectly suited to the professional level of QTVR photography that they used. This is a great approach to trench-journalism and the realness of the experience is almost frightening. An excellent use of the QTVR potential for really being a integral part of the storytelling.

It should be noted that although I criticize these websites heartily, there are few attempting to create a "real" experience such as these do. Most sites feature QTVR as a "web treat," almost an afterthought to creating a website. I would argue that 95% of websites using QTVR today are not designing the websites around the virtual experience, they are simply giving users an extra bonus treat for visiting. Realizing that QTVR is very new to the web, I expect this to change (slowly), but with the two website examples above, credit must be given for "reaching" with the QTVR technology and really attempting to create a meaningful experience with the panoramas, not just the typical "sit and spin" view of an office lobby.

Chapter 4

DESIGNING A VIRTUAL GARDEN

Lines In The Garden

Websites that succeed in using QTVR manage to integrate the design with the subject matter. Once I decided to create a virtual tour of the garden, I had to let the garden and it's natural strengths determine the design. The real garden is landscaped in a very fun and winding way. As was explained in chapter 1, QTVR is well-suited for the self-guided tour. The VR and webpages work well together and allows the virtual visitor to seek out what interests them. VR can communicate motion and a unique sense of place with motion, something photos and text cannot. Creating a sense of place was paramount in my design. So I examined the place carefully and first took notes on its feelings and landscape design.

Sketching a giant map of the garden allowed me to get a feel for the overall layout and feel of the lines in the garden. They were anything but straight and orderly! I tried to incorporate the playful character of the garden layout into the website. The garden is made up of over 50 "theme gardens" -- or plants in the same planter area grouped by a theme, (i.e. - Cloth and Color Garden, Bog Garden, Cereal Bowl Garden, etc., see also discussed in chapter 1). None of these theme gardens were ordered in any way, they were just randomly thrown around the paths in decorative ways. Trying to organize what I saw before me into a coherent navigational system would really be a challenge. But visual structure would be key to the user not always feeling lost or disoriented, especially when they used the QTVR movies. I desired to balance the random "strolling through" feel of the real garden with a structurally consistent visual interface.

I made the decision to make the website without using Navigator's "Frames" feature. Using Frames is a controversial layout method, only available to certain web browsers that splits the page up into several smaller pages (as used in "Witness: Roads to Refuge", above). I chose the non-frames format to keep it as simple as possible and let the garden images lead the design, not the "web look" that frames often imposes. Using frames to design a webpage certainly has many advantages, but I decided to develop my structure as simply as possible, so the design of each single page would contain enough information for the user to navigate within the website.

Maps and QTVR Context

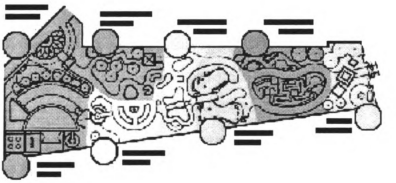
With the absence of frames, a uniform visual structure was critical, because each individual page must contain enough contextual cues and navigation to get deeper or shallower in the given information, without feeling overwhelming or cluttered.

> Organization and visual structure provide the user with the visual pathways needed to experience a product in a systematic way. Structure affects the visual experience at its most primitive level because it is the first aspect of the display to be perceived as information is extracted and used to guide subsequent interaction. (Mullett, 1995).

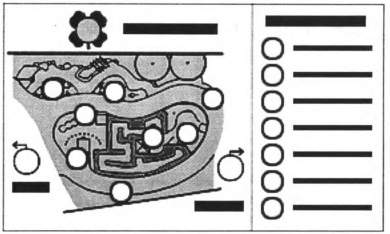
And what better guide than a overhead map, showing the node location of each theme garden? That is, each node on the map would represent a panoramic QTVR movie. An overhead view is a pictorial way to represent all the playfulness of the lines, converging paths, and crazy-shaped outlines of the theme gardens, while still providing context and relationships of where items were. I felt my own freehand sketches of the garden were way out of scale, so I adapted an overhead map from the original garden blueprint by Jeff Kacos and Deb Kinney. This blueprint was a scale model of the garden's layout. Unfortunately it also contained many of technical notes and extra mechanical details that were helpful to a builder or landscaper, but clutter to a software users. I digitally cleaned up the blueprint, emphasized the lines and areas I thought were important, and erased

information that I thought was meaningless for virtual visitors. I also loved overhead nature the map because I saw interesting patterns and shapes for the first time that are more difficult to perceive when you are walking on them in the real garden.

By getting the giant map to finally fit on in a browser window that was 470 pixels wide, I realized that there were still too many nodes to fit on a single map. It looked too cluttered and the cute paths of the garden disappeared under too many labels. Thus, a further organizational problem existed: How could I break the large map up into smaller maps without losing the context of what other theme gardens were still near each area? I drew borders around areas I thought were natural boundaries, and named them "area." Each "area" contained up to 10 "theme gardens." Each area was given it's own tint, brightly colored like the flowers contained therein.



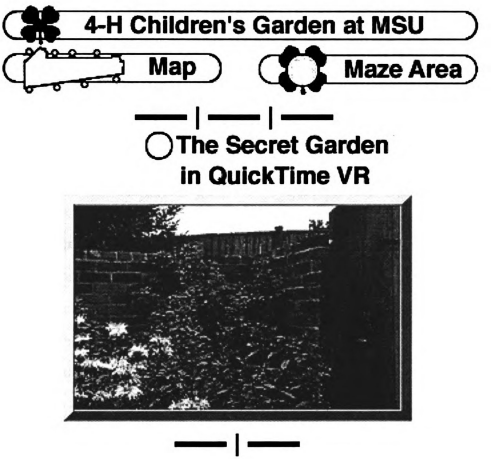
I color coded each area and the "overview map" suddenly had a more useful purpose; to provide "zoom in" areas for clusters of theme gardens near each other. Once the user selected an area, like the Maze Area for example, the individual theme gardens are represented as white dots, each with a number. Each area is given a letter and name as well, which appears color-coded at the top of each screen. Also at the top of each screen is a small icon and label of the familiar "overview map" reinforcing that which the button represents. This was the most used button in the user testing (discussed in Chapter 5).



Once the user is at this "area" level, they may select a theme garden to examine. Users who are interested in their shape or placement on the map may choose from their position on the left map. Those intrigued by the actual names of the theme garden may chose from the "legend" of that area map on the right. Both dots go to the same location, reinforcing to the user that the dots mean theme gardens. Once a theme garden is selected, the maps recede and the plants in that theme garden are foregrounded. The page for each theme garden contains between 1 and 6 photographs of the overall theme garden in addition to close-ups and labels of the most interesting plants. These screens also have a small amount of text to explain what is planted in the garden, and explain the theme of why those plants are grouped similarly.

The idea of the theme gardens as groups of similar plants is crucial to convey, or the whole point of a "theme garden" is lost. I emphasized the gardens as individual themes by giving each one it's own webpage and panoramic QTVR movie, and reinforced this with the dot indicator for each one. These all serve as contextual cues. "Because the [contextual cues] are experienced effortlessly and automatically, phenomena at this level provide critical communication channels that can be used to supplement or interrupt the user's higher level activities." (Footnote: from Designing Visual Interfaces, Sano and Mullett again) Once the context of the theme garden and its purpose has been established, a QTVR movies of that garden is available. They are foregrounded at the top of the page in a prominent position. I decided to have the movies load on a sub-page, not to divorce them from their contextual content, but to not force 230k web download on a user who does not wish to

virtually experience that theme garden. If the user is interested in the photos and info about the garden, they may wish to explore that theme garden in QTVR, but they don't have to. Once the QTVR movie is selected,



all the labels from the previous garden stay as headers, but the QTVR movie takes the foreground in its own page. It is still "embedded" within the webpage, retaining the area and theme garden context, without being launched off by a helper application and detached from it's context. The option suggested from each panoramic vr movie is "back to photos", thus again emphasizing the connection between the theme garden's name, photographs, textual info, and QTVR movie. They are all different media representations of the same theme garden.

Headings, Consistency and Context

I wanted to allow the users a visual way at the top for them to instantly know their location within the larger "overview map," as well as to get back to a screen they recognize if they become disoriented. The long bar contains the title:

that will take the user way out to the contents page, which explains the project.

On the next line of bars, the "overview map" icon is on the left. Users are only a click-away from the "The Big Picture." On the right is the name of the particular area they are in. Clicking that bar will place them back at the magnified view of that particular area, so they can see the visual overhead context of their specific node, or to choose another node. This pattern, combined with the dots, works well to unify the navigation. Consistency and integrity of interface is key in bars that perform functions. Each bar does an identical action at each level of interaction.

> Without the integrity provided by a coherent visual structure, a design quickly becomes impossible to interpret and understand. The cost is functional as well as aesthetic, since progress toward any goal in continually impeded - even for expert users. (Mullett, 1995).

Navigation Issues

Different users navigate the web in different ways. I wanted to allow random jumping around within areas (the zoomed-in area maps) but also allow a linear-navigation for those users who want to see every theme garden within an area, or even the whole website. The dots are introduced to mean "theme garden," and appear next to each garden's name, reinforcing the "node" concept at every level the names appear. The dots

are numbered sequentially by a meandering path I chose through the garden, starting at the entrance and ending at natural exit (visiting every node). At the bottom of each page is a link to "previous garden" and "next garden". At the QTVR level this sequence is also carried out if desired, with "previous QuickTime VR movie" and "next QuickTime VR movie" to delight those who wish to navigate purely by the VR movies.

A "Site Index" (offered more as a utility for frequent visitors) is located beneath the overview map that lists every theme garden, in numerical order, in each of the defined map areas. This is useful if a user is looking for a specific theme garden or QTVR movie and does not wish to navigate down to it with the maps. They can jump to it from the index. There is also a "Selected Highlights" page that features 6 of the best individual theme gardens in the whole place, a shortcut for hasty web users who want don't have time or patience to browse through all 59 nodes.

The Whole Experience

Creating a virtual experience of a real geographical place on the web is difficult. How space is represented is divided up between the overview maps (macro), the QTVR panoramas (medium) and the photographs (micro). I felt that any of these three were not giving the full story of the area. The photographs have great strength because they can provide the beautiful and minute detail that a real visitor might get looking right into the heart of a flower. The QTVR movies provide an outstanding sense of local space, but with recognizable structures in the distance. They also provide visual cues of where they are in the larger layout of the garden. Finally, the maps work to show how far distanced each node is from every other, and also the beauty of how the theme gardens are physically laid out. Working at all three levels helps to present a sense of "place" in the virtual garden -- and sense of place is what I wanted to emphasize.

Chapter 5

REACTIONS TO THE VIRTUAL GARDEN

Experiences

This M.A. project is a production thesis, not a research thesis. The website element was not completed until mid-October, when the garden was nearly past it's season. In the tradition of software development, I at least wanted to check with a few friendly users to validate the web site design and lay the groundwork for formal research which may be conducted by the MSU Comm Tech Lab in the summer of 1997.

This chapter presents my observations of and discussions with four friends with four friends who used the software and visited the actual garden. Both the observations and discussions were informal and among friends. However, they provide initial insights into QTVR and lay the groundwork for formal research.

A fascinating question is how the experience of visiting the real Children's Garden and visiting the virtual Children's garden differ. What are unique properties of each? How effective is my project (especially it's implementation of QTVR) in representing the garden, and the elements I tried to emphasize in my virtual model? Another question is how do people actually use the website? Do they experience every QTVR movie? In what order do they visit real and virtual theme gardens?

My goal was not aimed at testing the usability of my software, though I was interested in those comments when they arose. What I wanted was to get feedback on the virtual and real experiences of the same place.

Who Visited The Gardens

To get an objective view of both the real garden and the virtual garden, I had only three criteria for my four testers:

1. They must have never visited the real Children's Garden, and they must have never seen my virtual garden.

2. They must be familiar with using web browsing software, such as Netscape Navigator. I wanted them to be focused on the experience of the virtual garden, not how to use the "software container" for the project. If they had a basic knowledge of how to move around on the web, this helped alleviate the novelty effect of first time users on the web (who might emphasize the joy of actually "being in cyberspace" rather than concentrating on the website content at hand). I also wanted an equal number of males and females for curiosity regarding gender differences.

3. They must be people I know, willing to do me the favor of offering their opinions.

To see how the virtual and real gardens complimented and differed from each other, I asked two people to explore the virtual garden first, and the real garden second, referred to as "vr-1st." Two people explored the real garden first, and the vr garden second and will be referred to as: "real-1st." There was one male in one female in both groups, exploration occurred individually. After both experiences were complete, we discussed the real and virtual gardens.

Comparing The Real and Virtual Gardens

User experiences are all different. This is not to say that these users replies are the "correct" way all users "should" or "will" feel this way about the two gardens. But this analysis does shed light on some important issues about how virtual space differs from real space, and how the perception of one affects the other.

Order of Viewing Matters

All four people felt that the real garden gave them "a stronger sense of wonder about the experience of nature" than the virtual garden did. All four also agreed that "the two gardens seemed like the same place."

Three of the four users said that they would like to see the Virtual Garden first and then the real garden. Both members of the "real-1st" group said they would have rather seen virtual first, citing comments like "you could visualize it so well. In the virtual garden it's easy to get a sense of what's where."

One real-1st person, noted: "I didn't see a map out there, [in the real garden] I looked for one [walked back to starting point to look for a labeled map] and couldn't find one. In the virtual garden I found it really easy to get a sense of what was there... what I might like to see in the real garden, what I might like to especially pay attention to. So, definitely virtual, then real."

A vr-1st person, noted that she liked seeing it the way she did, with the virtual garden first. She saw the themes and areas better, and noted that there was little done in the real garden to direct people to groups of plants. "People like groups." She said the navigation in the VR garden helped, and she was able to map the concepts with the photos, which she though of as "icons" for the theme gardens. I was glad to hear this because it is exactly what I hoped to accomplish with the photos.

Another vr-1st user was the only dissenting opinion. He noted that he would have rather done the real first, because "to experience something, you really have to experience it first hand. My motivation for the virtual experience is for curiosity and comparison."

All four users did note that whatever order they chose, seeing both was more desirable than seeing just one or the other. One explained that would be best for "the maximum experience." Another was of the same opinion, and added: "Seeing the virtual would definitely be a good impetus to go to the real." This is also reassuring to know!

Which garden each user went to first had a definite impact on their experience. The two that saw the VR garden first cited advantages of: knowing the groups better and clearer navigation: "I knew the general layout." A curious note was that "by seeing the virtual first you knew that it wasn't always a calm, serene environment... you could see trains, parking lots." The garden was not set in a remote, totally pastoral environment as perhaps the observer had previously thought. Thus, the virtual garden effectively communicated the "island" of plantings in an otherwise urban setting.

The vr-first people were split on the disadvantages. One vr-1st person remarked "in some areas the vr worked better than others... sometimes you struggle with moving, only a couple feet away, because some things were so close... I put things together in my head so things were organized a little bit differently." She commented that it was interesting to have it all placed in your head and then have it actually be elsewhere. She also noted that because she didn't start the virtual garden at the "front door" (i.e - theme garden #1) she didn't get that same feeling of "starting out" as she did in the real garden.

The two people who saw the real garden first noted one of the same advantages as those who tried the opposite order, such as already having a mental model of the layout. This indicated previous perception as central to both groups experiences. Since everyone cited this as an advantage, it illustrates that users liked having a mental model of the place and sought that as a high priority of the "experience," whether they got the mental model from the virtual or the real, having it pictured in their heads was a priority for enjoyment.

The real-1st people noted how seeing the real first detracted from their experience. One said that by after seeing the virtual, she wanted to go back to the real because she felt like she had missed a lot because of the markings. She didn't think the gardens were as clearly marked as the website. This point came up repeatedly.

The other real-1st user said seeing the real first detracted from the overall because once he had smelled the flowers, he thought "there's no way they can capture this" (in the virtual), and found this factor to be disappointing. A definite advantage of seeing the real

garden first was seeing others getting enjoyment there in person, said one user. "You do see some children in the vr, but when you see kids there in the garden all playing..." it made her want to go back to the real at different times. Another advantage she noted was after seeing the real, she was curious to see how the creator represented certain parts, "to see what the artist took from it." This made it enjoyable not as a virtual garden purely to represent the real garden, but as an artistic interpretation.

Overall shortcomings of the VR garden noted were the lack of smells, touch, and even sound. All users commented that they missed the smells in the virtual garden. An important advantage of the VR garden was it's ability to be seen year-round at it's peak, unlike the real garden which is dead much more often than it's alive. A commented was that "there were not many (sensory) strengths, but as far as sight, the virtual garden has the ultimate strength of being available year round." Another advantage of the virtual garden noted was thorough labeling, much more so than the real garden. The virtual garden was described as very "fast" visually, with "instant visual gratification."

Impacts of Experiencing One and then the Other

All 4 users indicated that there were items or places that they saw in one garden that they wanted to seek it out in the other.

Those who saw the virtual first reported that they wanted to actually visit specific places. One person was interested in the Monet Bridge and The Treehouse, because they were neat places to see in the VR garden, but actually "rewarding" to do it for real. Thus by making the VR exciting, it can entice users to find those items out in the real! The Treehouse and Monet bridge are larger features of the garden that offer unique perspectives "from above" in both the virtual and real garden.

A vr-1st user was interested to see the scale of objects once she got to the real garden. Seeing them on a webpage is not the same as having something tower over you. She wanted to see just how big the Maze was, how small the Secret Garden was, and the

detailing on the Treehouse. A real-1st user wanted to find places in the virtual that caught his attention in the real, such as the maze, the sunflowers, and the train tracks. The other real-1st user, after seeing the real garden first, was very interested to see what areas she though it would be difficult to represent in the virtual garden. She commented:

> The pond, even though it wasn't one of my favorite parts of the garden, I was really interested to see how you could get the feel of water on the virtual garden. I though that would have been one of the most challenging things because it was moving constantly. Constant motion was impossible on the virtual. (vr-1st user)

Again it is important to note that users have an interest in not only the subject matter but the representation of that, curious about how to virtually show fountains in the air. Designers need to pay attention to these items because users are!

An advantage of the virtual garden was being able to see what the colors looked like at a different times of the year for comparison. The virtual garden was photographed at peak season, in July and August. The tour for the test was in early fall. "I was interested in the colors, how they've changed, I really wanted to see what they looked like at a different time of the year," one user said. "Some of them had changed completely in color and others that I thought would have changed over the months were exactly the same."

Only with two versions of the same garden could this comparison even be possible. The real garden is only open for about a third of the year, and the plants are at their peak for only about 2 months. With the virtual garden, though you cannot see the changes with the season, it does show the garden in its finest hour. This way the garden can be toured (virtually) even in the dead of winter.

Perception of Themed Gardens

Both the real garden and the virtual garden are composed of "theme areas." I asked users if or how they could perceive the groupings of similar plants in the virtual and real garden.

The virtual garden reportedly emphasized and labeled the groups better than the labels in the real garden. A vr-1st user noted that some places in the real garden he didn't "get" the overall theme, and sometimes when looking for a theme title he would read a donor plaque. He was glad there were no donor plaques in the virtual garden, as he perceived them as worthless on an garden-informational level. The other vr-1st user was glad for the overall theme garden labeling in the virtual garden, though cautioned again over-labeling as it "can get cumbersome." All four users remarked at more than one time in the interview that the labeling of theme gardens in the real garden was inconsistent and sometimes unclear. Seeing this as a disadvantage in the real garden myself, I corrected this shortcoming in the virtual garden.

Navigational Patterns in the Virtual Garden

I was unable to find any published research about what users do with QuickTime VR. We know what they can do (spin around, zoom in, zoom out, look-up, look-down). But what do they actually do, in the context of a virtual experience? My informal observation of four users helps to identify the kinds of behaviors that could be fruitfully examined and quantified in a formal study.

How users moved around in the virtual garden was of particular interest, there appeared to be a different method depending on which garden was experienced first. The two that used the virtual garden first navigated more methodically, carefully forming their mental models. They generally started somewhere and browsed gardens in their area, sometimes sequentially using the "next garden" and "previous garden" links. When asked about this they said it was because it was their first time seeing it, and they wanted get their bearings. They often would be down using QTVR of a theme garden and then hit the "map overview" button to surface (and place where they were), only to dive back down again. Only after the VR-first users got a sense of place did they may select a theme garden based on an interesting name.

But the two users who visited the real garden first were opposite. They said they sort of did an overview of the real garden to get it's boundaries and see what was there, and then walked around the real garden in a large circle to get a chance to see everything. But then when they used the virtual garden, they skipped around and were not as methodical as the vr-first group. One was interested in "going to certain areas that stuck out in your mind," and the other was intrigued by theme gardens with amusing names, (like the Fairy Tale garden), perhaps because many names are not marked in the real garden.

These navigational patterns tell us as designers of experiences that we must allows our users a variety of methods for moving around. A random, non-linear method (like the maps and site index) should be provided for those who want highlights. This is also a feature not possible in the real garden (to be able to pop around from one end to the other, stopping at gardens with interesting names). A linear method is possible for users who want to see everything, or browse sequentially.

The QuickTime VR Factor

None of the four users had ever experienced QuickTime VR before. How they used QTVR in the virtual experience was a big concern to me. Did they use it, did they think it was necessary? Well, all users said they felt satisfied with the level of visual detail in the virtual garden, which was good to hear from a designer's standpoint. I asked the users how they navigated in the QTVR movies. At first some were excited just to have control of their view, and would zoom in and out. Most spun around in the 360-degree range to "get their bearings first." One would zoom in or stop a rotation if a color caught her eye. Two users both looked in the QTVR movies for adjacent gardens that looked interesting, and wanted to go to them. One liked the QTVR movies that had other recognizable objects in them, to give a sense of place. For example: "Was the treehouse up close in the QTVR or farther away?" I conclude that seeing tall, recognizable objects within

the QTVR panoramas gave users a better sense of their relative location than movies that did not contain landmarks.

Users expressed some degree of frustration that they couldn't look up or down very far. This is a limitation of the software that is true across all QTVR that I have used, and it is an important criticism. The panoramic window creates more of a horizontal "boxed" effect. They also complained that it was hard to get a sense of moving "forward" in the QTVR. This is because I only used single-node movies to keep them small for web downloads. The CD-ROMs I reviewed (Chapter 3) don't suffer from this problem because they are linked from movie to movie. A significant drawback of using QTVR on the web is that the file size of multi-node movies results in unacceptably long download times for users to experience it (thus a design sacrifice for bandwidth reasons).

Reasons users had for wanting to download a particular movie were varied. Most users downloaded a QTVR movie if it was present on the webpage. This was reassuring! One user wanted to look in at the QTVR movies to see what was next to her. The other looked at every QTVR movie he came across, but later noted "if there was a QTVR movie I didn't chose ,it was because from the photos it didn't look interesting." All four users agreed that the QTVR movies taken from unique perspectives were most interesting. For example the observation tower is high above the garden, and I shot that QTVR movie from a place an adult normally wouldn't climb up to. The art of perspective is a definite strength of QTVR. You can give users a different feel than just an eye-sight level shot, and often an unconventional perspective adds flavor or character. This was an important finding to me as a designer. I was curious if the different perspectives would confuse, but instead they seemed to intrigue.

All the users agreed heartily that they would much rather control their own view with the QTVR than be able to see a pre-recorded video clip of a panorama of the same site. Users wanted control of their view on the web, and at this time it is only possible through QuickTime VR.

Comparing The Media Elements

There are four media elements of the virtual garden: QTVR movies, text, photographs, and maps. Three users liked QTVR the best, saying the QTVR movies were "very important for enjoyment." "contributed tremendously to my enjoyment." The reaction to the photos was also positive. One user noted that the photos worked like icons of the highlights in the theme gardens of the most recognizable things. Another liked the photographs as better than the QTVR movies, which she still said were "very important for enjoyment" but liked to see the art of good photography, which helpful to visualize. One user liked the 360-degree panoramas but noted that often only 180-degrees of them made sense in a given context. All four users found the maps helpful, (one remarked "it what was missing in the real garden!"), and all found the text least interesting compared to the QTVR, photos, and movies. All users said that the text was just enough if you wanted to read it, but no more than that.

This is a very intriguing finding. In the virtual garden, labels and maps are important for visual communication. The QTVR movies and photographs rank highest. But do media designers do with text? In an experience that is intended to be visual I realized it is best to keep it short and out of the way, available if users want it, but easily ignorable as well. When a virtual experience is mean to show a place, then let the sights lead.

Tour Guides

There were no tour guides in the real or virtual, and all users views agreed that the self-paced virtual tour allowed you to be your own guide. One user remarked that "the VR is interactive enough." Another enjoyed browsing in both the real and the virtual at her own pace, and "wouldn't want to be rushed."

All users expressed a modest interest a hand-held information device. If one was offered they would take it. One would use a hand-held device that contained the website information and maps. Another noted that any guide's most important feature would be the ability to shut if off if desired.

Do Other People Belong?

What to do with other people is always an interesting concept in the virtual representation of something. QuickTime VR is criticized for how it deals with people; it freezes them in a scene. This is something you'd never see in real life - a frozen person. An interesting question is how the presence of frozen people in the QTVR movies and the presence of moving people in the real garden affected both experiences. Reactions varied widely. I conclude that this answer depends a lot on personality type as much as the virtual experience itself.

Everyone noticed people in the QTVR movies. Two users liked them, and thought "it added life." The other two users didn't like people in the virtual garden. One thought any more people would distract or get in the way of what he wanted to see, and the other didn't want any in the VR garden -- but also noted that this was strange because she loved seeing people in the real garden. Two users noted that it would be funny if there were people caught in silly poses and you could zoom up to see their facial expressions.

All four users toured the real garden when there were other people there. All didn't mind other people but wouldn't have wanted too many. One thought the people added a nice social element and another would have added more children, if anything.

All users noted that visiting the real garden with someone would be pleasant. They wanted to make comments such as "look at that flower over there." Oppositely, only one user would have wanted to experience the virtual garden with a friend. The other two saw the virtual garden as more solitary experience, to be best done alone. The final user said they would enjoy the virtual garden equally alone or with a friend.

Evidence in inconclusive about adding or removing other people from a virtual experience. These four users preferred to experience the real garden in a more social environment than the virtual garden.

Chapter 6

CONCLUSIONS

Design With Tools For the Task

Creating the virtual Michigan 4-H Children's Garden using QuickTime VR took good advantage of this new medium. The charming sense of place in the real garden is very strong and I utilized the QTVR technology to carry that same feel to the web. Despite the severe interface restrictions of the web, the informal users seemed to feel it was a success. The freedom to look around a wondrous place that you have never been is exciting! New media designers can realize the potential of QTVR in virtual tours of museums, virtual travel, and distance education.

If Software Development Was Utopian

In retrospect I could have done several things differently. One would be to have a machine that controlled the weather patterns in Michigan. Everyday I scheduled the proper equipment to shoot QTVR, the weather changed, and (more often than not) partly-cloudy days interfered with quality VR panoramas.

I would have also had a machine to stop the growth of the garden at it's peak time in mid-August. That way I could shoot all the QTVR movies and still photographs while the garden looked its best, not over the course of the summer and fall as I had to. I would have finished the project earlier in the growing season, to have time to conduct formal research.

In-depth discussions with four user friends was great for lots of rich feedback, but these are not results that can be generalized onto the general population of web users. The

observations raised here do provide a basis for designing and conducting research on user reactions next summer when the garden is in bloom again.

What Have I Accomplished?

Despite these limitations, I feel new media designers can learn a lot from my criteria for designing an experience. I did not try and depart from the natural allure of the garden, it's mission or look. I tried to take what the garden did best on its own and augment it with technology fitting to the subject matter. Also beneficial is the immediate and global availability that having the virtual garden on the web will provide. Now the garden can carry it's mission forward to curious virtual visitors in any country.

The user feedback is important to celebrate the software's success and note it's shortcomings for future versions and designs. While it can never replace the real garden, the virtual garden has many valuable features that the real garden can never have. As the users commented, experiencing both the virtual garden and the real garden is the most fulfilling overall experience.

The Future of QuickTime VR Experiences

I used QuickTime VR 1.0 to create my QTVR panoramic movies. As with a first version of any software product, there are many initial problems to work out. The image-stitching software is tortuous to use and the documentation is not much better. The RAM requirements are extreme, and the features of the authoring tools are basic. The QTVR movies themselves have many limitations as well.

Apple has announced QuickTime VR 2.0 with many new features and better tools. This was met with a worldwide sigh of relief by QTVR developers. Most importantly in my specialization, QTVR movies can have hot-spots that can take a user to different webpages. This would allow a whole new (more immersive) method of virtual navigation on the web: entirely through QTVR panoramas! (O'Connell, 1996).

This takes QTVR out of the paradigm of being an isolated object on a webpage to actually being a dynamic part that can act on other web documents. Other exciting features include support for audio, including speech and directional sound. Moving digital video will also be incorporated, so that designers could embed other QuickTime movies or 3-D sprites into QuickTime VR Panoramas. Carlos Montalvo, director of Apple's interactive media group announced "QuickTime VR technology is... transforming the content landscape from Web sites based on static text to Web sites based on interactive virtual environments."

Designers will doubtlessly create more wonderful QuickTime VR movies with the new set of tools. More exciting hybrids will be developed with virtual reality and the internet. But it is important to remember as we incorporate new technology into our work, designers working with virtual reality must strive not just make quality software but to design full-on experiences.

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