3D K9: USING QUICKTIME VR TO TEACH VETERINARY ANATOMY

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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

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A well-developed understanding of spatial anatomical relationships is an essential skill for individuals working in the field of veterinary medicine. To aid in the acquisition of this important ability, this multimedia project was created to assist veterinary technology students in learning canine skeletal anatomy in three dimensions.

The program will supply the learners with accurate information regarding anatomical landmarks, current nomenclature and proper pronunciation. Students will be able to continue the learning process even after the lab has closed or the gross anatomy portion of their course has ended.

The virtual specimens will be distributed to students on CD-ROM. This universal and versatile format will allow them to view the material on any modern personal computer at home, work or school.

ACKNOWLEDGEMENTS

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CHAPTER ONE

INTRODUCTION

During the first year of the veterinary technology program, the subject of anatomy is taught using cadavers and other preserved specimens. This approach is effective, but leaves the student dependent solely on their experiences in the course and two-dimensional atlases for the rest of their career. This project was created to assist veterinary technology students in the understanding of spatial anatomical relationships. The goal was to create a supplemental virtual anatomy experience that was available to each student twenty-four hours a day. What is learned during this project will be of benefit to students of both veterinary and human medicine.

Digital specimens were created using QuickTime's VR object technology. This technique involves photographing the individual bones of a canine skeleton from a variety of angles and then stitching these photographs (2D) together using specialized software. This approach is far less expensive and time consuming than high-end volume rendering packages such as 3DS Max or Maya, which require intricate modeling of surfaces and volumes and don't have the appearance of real tissue. The QuickTime VR process combines the still images to produce a photo-realistic object (3D) that can be manipulated with a mouse and viewed from any angle. The procedure can be completely automated, and a specimen can be photographed and processed in less than fifteen minutes.

The hardware and software used to accomplish this task cost less than $2000 and can be installed on a typical desktop PC. The Magellan Desktop Turntable is the cornerstone of the system. The specimen is mounted on this computer-controller turntable and photographed every ten degrees. A total of thirty-six images produce a high quality model with very smooth rotation. A digital camera with remote capture software allows the images to be acquired without unintentionally altering the camera's position. Each camera option (flash, focus, exposure) is controlled from the PC. A custom profile is created, and the settings are applied to each image to ensure consistency between shots. The specimen is illuminated using a standard radiograph viewing box, which provides a diffuse fluorescent light source. No additional lights or camera flash are required.

Adobe Photoshop is used to perform minor corrections to each image and outline each anatomical landmark. The image series is then imported into Macromedia Flash to create an interactive computer-based anatomical atlas of the canine skeleton. The program can be viewed on any computer using the free Macromedia Flash Player software. The virtual atlas is distributed on CD-ROM and can also be made available online using a streaming server.

PROJECT OBJECTIVES

The objective is to design an instructional tool that makes it fun and easy for veterinary technology students to learn canine skeletal anatomy. This learning tool will initially be distributed on CD-ROM, but an online version may also be made available in

the future. The program will be easy to use, allowing the student to focus on learning the

material rather than the interface. When the project is complete, the student will have a

computer-based supplement to the standard cadaver specimens used for instruction in the

anatomy course. This resource will be available to them later in their clinical rotations

and also in their future careers.

PERSONAL OBJECTIVES

The primary personal objective is to learn more about how computers and

technology can be used to enhance medical education. The advantages and

disadvantages of the QuickTime VR format will be explored, as well as alternate 3D

authoring tools and methods. The author seeks to improve his digital photography skills,

and become more adept at using multimedia authoring programs such as Flash MX and

Live Stage Pro.

This paper is a supplement to the CD-ROM multimedia production. The

document addresses the importance of anatomical knowledge and spatial understanding

for individuals in the veterinary profession. Multiple methods for creating three-

dimensional models and simulations are discussed. The design process is described in

detail, including important highlights of the pre-production and production processes.

The final chapter summarizes what was learned from this project, whether or not the

objectives were met and how it can be improved and expanded upon in the future.

CHAPTER 2

LEARNING ANATOMY

A well-developed understanding of spatial anatomical relationships is an essential skill for individuals working in the field of veterinary medicine. This knowledge is vital for technicians, practitioners and surgeons alike. It serves as the basis for more complex subjects such as understanding physiology, diagnosing orthopedic diseases and interpreting multiple imaging modalities including radiographs, computerized tomography (CT) and magnetic resonance imaging (MRI).

At the vast majority of institutions today, anatomy is taught using physical specimens. The samples are only available to students in the laboratory during restricted hours. This approach severely limits access to the learning materials. To help alleviate this problem, students enrolled in Michigan State University's veterinary medicine program receive what is called a "bone box" to take home and study. This resource contains a disarticulated canine skeleton and is very useful for the first few weeks of the anatomy course. The students must be careful not to lose or damage the samples since they are costly to replace. The bone box must be returned as soon as the first section of the course has ended. This method has been very successful in helping veterinary medicine students learn skeletal anatomy.

Due to limited funding and program resources, students in the veterinary technology program do not receive a bone box to help them learn anatomy. All of the

specimens needed for their education are kept in the laboratory. This is very

inconvenient since many of the students would prefer to learn the material at home on

their own time. The majority of students in the program have hectic schedules outside of

class. Most are working part-time or full-time jobs in order to finance their education.

Many spend over an hour each day commuting to campus and have very little spare time

to spend traveling to or studying in the lab. However, most feel that there is no other

option. Most students in the veterinary technology problem describe themselves as

hands-on and visual learners. They learn best when they can physically examine and

manipulate the specimens.

It can be difficult for students to learn anatomy from the two-dimensional

resources and atlases that are currently available. Some people have considerable

difficulty transitioning from a flat, two-dimensional picture to a three-dimensional real

life object. In many atlases, anatomical landmarks are poorly labeled. A confusing series

of lines and arrows are used to point out all of the important structures on a specimen

which can be very overwhelming to students. Many students admit that their costly

anatomy guide books are "gathering dust" because they were difficult to understand or

contained nothing but text.

Students have the potential to benefit greatly from having full-time access to all

anatomical specimens that are used in their courses. They should have the ability to learn

the material on their own time, at any location they choose. The specimens must be

convenient and inexpensive to access. There should be minimal penalty involved if the

specimens are lost or damaged. A few short years ago, this elaborate vision would have

been impossible to fulfill. The primary problem has been devising a solution that is both

advantageous and cost-effective for the user. Today's imaging and multimedia

technologies can make this vision a reality.

CHAPTER 3

3D IN MEDICAL EDUCATION

Technology available today allows for the creation of digital anatomical specimens from a wide variety of samples. Different methods such as photography, laser scanning and radiographic imaging can be used to construct three-dimensional models from specimens both living and preserved.

Virtual models have several advantages over two-dimensional images and even their physical counterparts. The digital specimens can be distributed very inexpensively using recordable media such as CD-ROM or DVD. The models can even be incorporated into web pages or downloaded as interactive programs. Such a far-reaching cost-effective approach gives the maximum number of learners access to the highest quality material possible.

Three-dimensional models allow the student to move out of the flat two-dimensional world and actually interact with the specimens being studied. With a few simple movements of a computer mouse, the sample can be rotated and manipulated as if it existed in the student's hand. They are no longer passively memorizing information, but instead are actively participating in the learning process. Capabilities exist in the digital world that are impossible to create with ink and paper alone.   The experience can contain animation, interactivity and even audio narration.

With so many capabilities and such tremendous potential, it is puzzling why this technology is not being utilized to a greater degree in medical education. A standard web search yields a limited number of human medical examples. Veterinary examples are even rarer. One of the largest libraries of QuickTime VR object movies resides on Wright State University's Department of Anatomy web site (http://www.anatomy.wright.edu/QTVR/). This resource contains approximately one hundred different specimens. Samples include bones, organs and partially dissected specimens. Each file is available in a variety of different sizes and qualities to accommodate a broad range of connection speeds. The samples are of high quality, but no anatomical landmarks are labeled.

Another site worth mentioning is the eSkeletons Project (http://www.eskeletons.org/). It contains a wealth of information about human, baboon and gorilla anatomy. Still pictures of bones from the three species can be viewed from a variety of angles. There is also an option to compare bones side by side. Landmarks are labeled for some of the views, but not for all. Many of the bones can be viewed as an auto-rotating three-dimensional rotation. However, the user cannot interact with this movie or enable landmark labeling. The animations are three-dimensional volume renderings and do not have photo realistic textures.

Several other sites make use of the QuickTime format as a solution for organizing CT and MRI image data in a user-friendly format. The University of Aarhus in Denmark (http://www.intermed.dk/qtvr/) and Murdoch University in Australia

(http://www.ascilite.org.au/ajet/ajet17/phillips.html) have both developed pilot projects using this technology. Hundreds of radiographic images are combined into one compact QuickTime VR file. By simply dragging the mouse, the user scrolls through each image in the study. This is a convenient method to distribute the materials to students.

The U.S National Library of Medicine has made a wealth of three-dimensional data available to developers with the creation of the The Visible Human Project (http://www.nlm.nih.gov/research/visible/visible_human.html). High-resolution CT and MRI images of both a male and female cadaver are available for purchase. While the level of detail is impressive, the image data set is massive at approximately 40GB in size. The material is raw and unlabeled, and requires an experienced anatomist to interpret it and use the data to its fullest potential. Each image "slice" must be meticulously analyzed by a medical professional in order to properly label the anatomical areas of interest.

Primal Pictures (http://www.primalpictures.com/sub_home.asp) is an excellent resource of three-dimensional models and animations of the human body. The models can be rotated in any direction and layers such as skin, muscles and blood vessels can be added or removed. The material is accessible via a standard web browser and is also available on CD-ROM. A Pocket PC version was recently created, giving students and practitioners even more freedom to use the resources how and where they see fit.

The goal of this project is to create a veterinary resource that uses the QuickTime VR technology to its fullest potential. The author hopes to learn from what others have accomplished and take QuickTime VR to the next logical step.

CHAPTER 4

DESIGN

Designing an interactive educational tool requires content expertise, skills in multimedia authoring, knowledge of current distribution technologies and the ability to design for learning. The focus of the creator should always be centered on the content, and not merely on the technology that is used to deliver it. Media and technology are meant to support the content, not replace it. Employing the theory of instructional design, the learning goals of the target audience were analyzed and the project was designed to meet their needs. To produce an effective educational product, careful attention must be paid to design methods, product usability and the proper delivery format.

MULTIMEDIA

The term "multimedia" is defined as using more than one type of medium such as text, graphics, audio, 3D or video to deliver a message. The goal of the designer is to seamlessly combine these various media types into one project. The integration should be transparent to the user and deliver an experience greater than that of the individual components. Multimedia should only be used when it can enhance the effectiveness of the teaching tool.

INTERACTIVITY

The goal of interactivity is to make the user an active participant in the learning process. The learner is no longer governed by the pace and scope of the educator. Today's student desires the ability to assimilate information at a rate that they see fit. Existing tools and technology make it possible to achieve this goal. The learner is in control, accessing what they want, when they want it.

USABILITY AND ENJOYMENT

One of the primary goals of the author is to make the project fun and easy for the student to use. The user must have immediate and direct access to the information they desire. There will be minimal time spent on learning navigation and how the controls function. The interface elements will be clearly defined, well organized, and consistent throughout the multiple areas of the project. Most importantly, the user should enjoy using and interacting with the application. Even though the ultimate goal is to educate, there is no reason why the user can't have a good time while learning.

DELIVERY FORMAT: CD-ROM

There are several advantages to using the CD-ROM format as a delivery method. Depending on the media type used, between 650 and 700MB can be written on a single disc. This enables the author to include various media types, such as high-quality digital video or audio, in the production. The discs are inexpensive to produce in mass quantity, translating to a lower cost for the student. Every asset of the project can be included on the CD-ROM, eliminating the need for an Internet connection to download additional

files. The majority of modern computers have the ability to read this media type,

allowing the student to use it at home or bring it to school or the workplace to use.

CHAPTER 5

PRE-PRODUCTION

It is crucial to plan a multimedia project before beginning the actual production process. The content area must be thoroughly researched and the scope well defined. The author must know detailed information about the target audience and how they will use the final product. The author should have an idea of what tools will be used to create the project, how the content will be organized and suitable methods for distribution. User-centered research tools such as persona development and focus group discussions are very helpful in customizing a production for a particular audience.

MATERIAL COLLECTION

A written list of terms was obtained from the director of the veterinary technology program. This resource contained the names of specimens and landmarks that a veterinary technology student must learn during the anatomy portion of their education. This list was used as a guide during production. It was important that all of the mentioned landmarks be included in the final version of the project. Any deletions or additions would lead to confusion on the part of the student.

CONTENT RESEARCH

For each specimen included in the project, it was necessary to thoroughly research all of the landmarks in a current anatomical atlas. The two publications used were Miller's Guide to the Dissection of the Dog: Fourth Edition (Evans, 1993) and Miller's

Anatomy of the Dog: Third Edition (Evans & deLahunta, 1996). This ensured the highest level of accuracy and avoided passing misinformation on to the student.

SCOPE

The original goal of the project was to include models of every bone of the canine skeleton in the production. However, as the project progressed it became evident that this would not be possible within the given timeline. Small, irregularly shaped specimens such as the phalanges, metacarpal and carpal bones were very difficult and time-consuming to photograph and properly label. Other samples such as the bones of the vertebral column were complicated enough to deserve their own project.

The bones that were included in the final version include the skull, mandible, scapula, humerus, radius, ulna, pelvis, femur and tibia. On a day-to-day basis, these are the most important bones for an individual working in the veterinary profession to know.

Each bone has many unique physical areas of importance, or anatomical landmarks. As illustrated in a typical two-dimensional atlas, this list can be very overwhelming for the student to learn. Fortunately, it is not necessary for the student to memorize each and every area. A list of the landmarks the student must learn for the successful completion of their anatomy course was obtained from the professors of the veterinary technology program. This reference was used to populate the project, thus avoiding extraneous terms or blatant omissions.

TARGET AUDIENCE

This project is designed for first year students in the veterinary technology program at Michigan State University College of Veterinary Medicine. Over the course of two to four years the students are trained in diverse areas including animal nursing care, surgical assistance, anesthesia, radiographic imaging, physical therapy and client education. The vast majority of the students in the program are female. They usually have less access to resources both inside and outside the classroom. Most live very hectic lives, working part-time or nearly full-time while they complete the program. . Many of the students must make a lengthy daily commute to campus. During the focus group discussion, the students stated that they learn best using hands-on and visual methods. A portable, three-dimensional supplementary resource for learning anatomy is ideal for this type of student.

The project will be available to students after the anatomy portion of their formal education has ended. They can use the resource later during the other areas of their education, during their clinical rotations or even in the field after they have graduated.

PRIMARY PERSONA

A persona is a fictional user created to aid in the design and development of a media project. It is impossible to design for "everyone", and oftentimes just as difficult to design for a group of similar individuals. A detailed persona allows the designer to focus on one representative user, complete with their own unique needs and concerns.

Elizabeth is 20 years old, and just started her first year in the veterinary technology program at Michigan State University. So far, she's found the credit load and busy schedule to be a little overwhelming. Each day, she spends about five hours or so on campus. It's her personal rule to be home by 6:00pm to take Cocoa, her chocolate lab, out for a walk. She only has time for a quick dinner and about half an hour of television before it's back to the books or off to meet with her study group.

Elizabeth lives alone in a one-bedroom apartment about thirty minutes from campus. The drive can be a daily frustration especially if there's a lot of traffic. However, she's very serious about her future career and won't let this stand in her way. She works part-time at a veterinary clinic not far from her apartment. She has always loved animals and has been working there since she was sixteen as a ward attendant and veterinary assistant. Her boyfriend Dave is a graduate student at the University of Michigan, and they only manage to visit each other about once every two months. Elizabeth loves to talk on the phone and, after her studying is complete, is often up to 1:00am speaking with Dave, friends or family.

Her parents bought her a new computer last year for her birthday, but she really hasn't used it much. She checks her email just about every day, but the Internet otherwise doesn't play an important role in her life.

INTERFACE DESIGN

A graphical user interface was required to integrate all of the materials. It had to be appealing in an effort to encourage use. It also had to be logical and easy to use. The goal was to have an interface that the student could use immediately, without any training or instruction. Many rough drafts were created in an attempt to combine the specimens, specimen names, landmark names and buttons. The final interface was created based on feedback from a graphic artist and an instructional designer.

TREATMENT

This educational project is intended to make learning canine skeletal anatomy fun and easy. The CD-ROM gives the student twenty-four hour access to a high quality virtual 3D skeleton. Specimens can be manipulated and viewed from multiple angles and specific landmarks can be turned on or off at any time. Audio clips are included to aid the student in learning the proper pronunciation of the Latin landmark names.

The specimens can be rotated using the mouse much like they can be in real life using one's hands. The project can be used at home, or on any of the computers on campus that are equipped with a CD-ROM drive. Since the project is self-contained on a CD, it can be played anywhere independent of the availability of an Internet connection or software plug-ins.

PLATFORM

The main software programs used to create this project are Adobe Photoshop 6, VR Worx and Macromedia Flash MX. The project is designed to run from CD-ROM on the Microsoft Windows platform. Every computer in the College of Veterinary Medicine and approximately ninety-five percent of its students use this operating system. A future goal is to develop a Macintosh-compatible version and include both versions on one hybrid CD-ROM. This dual format will have the ability to reach the largest possible audience of students.

FOCUS GROUP DISCUSSION

A focus group discussion was conducted in order to learn firsthand from students how a project of this type could be beneficial to them. It was useful to learn how the students felt about their current anatomy education and how they thought it could be improved. Ten first-year students in the veterinary technology program took part in the discussion. Participation was completely voluntary and many were eager to give their opinions.

The focus group discussion was very useful and yielded important information about past experiences, student lifestyle, computer skills and opinions of currently available learning resources. Several insightful suggestions were made and incorporated into the project prototype.

EXECUTIVE SUMMARY

The group had little to no prior experience learning anatomy when they started the veterinary technology program. They described themselves as visual and hands-on learners. They benefit greatly from the skeletons and other physical specimens that are available to them in the lab. Several participants have limited access to these resources since they have to commute more than one hour to campus each day. They have difficulty learning anatomy from textbooks and find these written resources more confusing than helpful. All of the participants have access to personal computers at home, and the majority has Internet access over a dialup connection. Most view the computer as a recreational item and not as an educational tool.

DETAILED REPORT:

1. Past anatomy courses

"Describe your experiences in any previous anatomy courses you have taken"

Responses indicated that the group had no prior experiences learning anatomy, such as during high school or in other undergraduate level courses. One participant stated that she "never had any anatomy prior to this..." and many others agreed, commenting that this made it even more difficult to learn the material.

2. Experience with other learning resources

"How easy or difficult is it to learn the material?"

The participants described themselves as visual learners and stated that they prefer the "hands-on" approach, rather than trying to learn the material from two-dimensional sources. One participant very eloquently described this as "I read all day, and it doesn't sink in. But if I actually see it, touch it, look at it rather than just reading about it…"

Several people said that some of the resources designed to help them are not even used. One participant commented that "it's too hard to look at a flat image…", "I don't even look at our anatomy coloring books…" and "they end up confusing me more than helping me…" Some textbooks have minimal value from the students' perspective as evidenced by the statement "one book doesn't even have pictures; you're reading it and oh yeah, that clarifies everything…"

Several subjects expressed varying degrees of confusion when reading their available anatomy books. Comments included "I'm reading the words but thinking of something else…" and "I can't look at it and come into lab and look at Gus (physical specimen) and have them relate…"

3. Lab and computer resources

"Describe your level of satisfaction with the laboratory and computer resources that were available to you."

The participants were very pleased with the computer resources and the physical specimens that are made available to them. There are an appropriate number of computers available in the lab and they are always in working order. All stated that they

find manipulating the specimens to be very helpful for the learning process. "The skeletons in there help me a lot; it's a 3D object and I can touch it and it's not flat..." stated one participant.

One student felt that learning from the skeletons was sometimes awkward with the statement "if you want to get at it at a weird angle you're on the floor; there's just not enough space in there…"

Several participants expressed interest in being able to have the same type of experience outside of the confines of the lab. "I'm a home learner and I have a problem staying focused around too many people..." mentioned one student. For others, the one-hour commute was the problem. One participant mentioned, "to have the time to go to the lab is rearranging my entire schedule. It would be nice to have something at home other than a book without spending more hours here to go to the lab..."

4. Computer skills and connectivity

"Describe your computer skills. How fast is your Internet connection at home? "

Every one of the participants had access to a personal computer at home. All but one stated that their computers were less than two years old. The general view of the group was that computers are useful for email and other recreational activities, but they don't have a high level of usefulness for education.

Most of the participants saw themselves as having moderate computer skills with statements such as "I'm internet friendly..." and "I'm pretty good; I get around..." One student described herself as a complete novice, while another felt she was quite advanced.

The majority had Internet access via a dialup connection. One participant had a DSL line, and another stated that she "has a cable modem, but our computer is pretty old..."

CHAPTER 6

PRODUCTION

The project details such as content, scope and target audience were clearly defined using pre-production techniques as described in the previous chapter. This chapter explains the actual production process in detail. This includes photography techniques, three-dimensional model creation and prototype usability testing.

A total of ten specimens were processed and included in the final version of the project. This included a complete articulated skeleton, the main bones of the head (skull, mandible), the forelimb (scapula, humerus, radius, ulna), the hip (pelvis) and the hindlimb (femur, tibia).
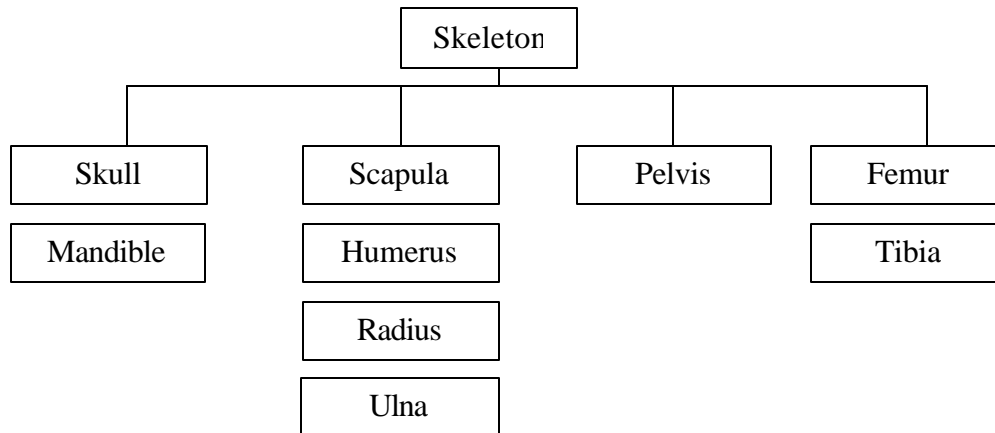
Figure 1: Specimens included in the production

Each specimen possessed a different number of anatomical landmarks that were individually researched and highlighted. Veterinary technology program faculty members supplied the list of relevant landmarks.

Specimen:	Landmarks:
Skeleton	10
Skull	11
Mandible	4
Scapula	5
Humerus	6
Radius	3
Ulna	5
Pelvis	6
Femur	7
Tibia	5
Total:	**62**

Table 1: Specimens and their associated landmarks

QUICKTIME VR OBJECT MOVIES:

A QuickTime VR object movie is a three-dimensional model composed of several individual photographs. As the user moves the mouse from side to side, they quickly scroll though the series of images, giving the illusion that they are rotating the object.

There are several authoring programs on the market that "stitch" the photographs together to form the VR object. Only VR Toolbox's VR Worx (VR Toolbox Inc., 2003) and Apple's QuickTime VR Studio (Apple Computer Inc., 2003) create QuickTime compliant files. Other software products have the same end effect for the user, but require their own proprietary software plug-ins to operate correctly.

Creating a QuickTime VR object movie can be complicated, but with the proper equipment the system can be automated and production time drastically reduced. The ideal setup requires two basic components: a turntable and a camera.

TURNTABLE

The turntable is the most important component of the system. The object that is being photographed must be tightly secured to a foundation and rotated in exact increments in order to achieve the three-dimensional illusion. There are several products on the market that accomplish both of these objectives. A Kaidan Magellan Desktop Turntable (Kaidan Inc., 2001) was used in this production to accurately secure and rotate the specimens. The turntable contains a pedestal on which the samples can be mounted. The system connects to a computer through a standard serial cable. The included eMCee Motion Control Software allows the user to define rotational speed and increments. The movements can be automated causing the turntable to rotate ten degrees every twenty seconds, for example. This level of precise control yields amazing and accurate results.

SINGLE VS. MULTIPLE

There are two types of QuickTime VR objects that can be created: a "single-row" movie and a "multiple-row" movie. The choice of format depends on several factors including production time and intended level of interactivity.

A single-row movie is an object that the user can rotate in one direction, such as left-to-right or up-and-down. It is composed of a relatively small number of individual photographs. The specimens used in this production were all photographed using the single-row technique. One photograph was taken every ten degrees, yielding thirty-six pictures for one complete rotation. The majority of turntables on the market are geared for the production of single-row object movies.

A multiple-row movie is an object that can be rotated in multiple directions by the user. The specimen can be rotated left-to-right, but can also be titled in order to visualize the top and the bottom. This type of object is much more complicated to produce and can be very time consuming. For each of the thirty-six positions, the camera must rotate completely around the object and acquire thirty-six individual images. This results in a staggering total of 1296 separate images per specimen. The end result is very appealing to the user as they can examine the specimen from any possible angle they wish. There are a limited number of turntables on the market that support the creation of multiple-row object movies and available products are often very expensive.

PHOTOGRAPHY PROCESS

A Canon G2 digital camera (Canon J.S.A. Inc., 2003) was used to take the photographs for this project. The camera was placed on a tripod and positioned approximately three feet from the specimens mounted on the turntable. A radiograph viewer box was used for illumination, producing a soft, diffuse fluorescent light. This lighting technique gave the specimens a realistic appearance without washing out their color and features. A large piece of black felt material was placed behind the turntable. This created a uniform background and made the light-colored specimens stand out visually.

The digital camera was connected to the computer using the supplied USB cable. The included Remote Capture v2.5 software allowed all of the camera's controls to be accessible on the PC. The settings were modified and a profile was created and applied to each photograph in the series. This profile was applied to each remaining specimen in order to automate the photography process and could be useful to others interested in QuickTime VR creation.

The Remote Capture software includes a timer function, facilitating the process of unattended photography. The interval rate was synchronized with the motion control software of the turntable. One rotation of the turntable and thirty-six exposures of the camera took approximately ten minutes to complete.

Minimal JPG compression was used and the images were transferred directly from the camera to the computer, bypassing the need for a memory card. Each file generated had a resolution of 2272 x 1704 pixels and was approximately 2MB in size.

Camera Settings					
Size	**Quality**	**Flash**	**Macro**	**WB**	**Exposure**
large	superfine	off	on	fluorescent	+2

Table 2: Camera settings

IMAGE EDITING:

Each image was imported into Adobe Photoshop for minor editing. The Magic Wand tool was used to select and modify the background. The felt had a slightly irregular texture and at times appeared as a dark gray speckled pattern rather than solid black. A high tolerance was specified for the Magic Wand tool, and any color that was black or dark gray was automatically selected. The Fill tool was then used to create a completely uniform black background. The Airbrush tool was used to touch up any areas not intended to be visible, such as the support pedestal. After each image was processed, its size was reduced to 400x300 pixels, the target resolution for the final project. This image dimension gives the best balance between specimen visibility and file size. The process was repeated for the remaining 35 images of each specimen.

DE-WOBBLING:

One common problem encountered during the production of QuickTime VR object movies is the failure to perfectly center the specimen on the turntable. It is especially difficult to center irregularly shaped objects, such as bones. The unintended result is the creation of an artificial axis of rotation. When the user interacts with the object, it appears to be rotating around something other than its center. This does not look realistic, and ruins the three-dimensional illusion.

The program called VR Worx was used to import the series of images and correct this problem. The software contains a special filter called "de-wobble". This option allows the user to visually align the object across 180-degree comparisons. The program corrects for any wobble or lateral drift, effectively minimizing the malpositioning. A QuickTime VR object movie is then generated, taking into account these modifications. No compression is used in order to preserve image quality. The file is then opened in QuickTime Player and the individual images composing it are exported as JPG files. This method is somewhat cumbersome but it manages to correct the problem.

ANATOMICAL LANDMARKS:

This was, by no doubt, the most complicated and time-consuming portion of the project. One of the primary goals of the production was to make anatomy easier for the student to learn. Most anatomical atlases use simple lines and arrows to point out the landmarks of the specimen. Each landmark is often illustrated from only one view of the

specimen. This becomes very confusing the student, especially when the specimen is

encountered in an orientation other than the one displayed in the atlas.

The intention of the author was to make the landmarks clearly visible to the

student no matter at which angle the specimen was viewed. Each of the thirty-six images

was imported into Adobe Photoshop. A new layer was placed on the top of each image,

and its alpha value set to 25%. This made the new colored layer semi-transparent, but

still let the details of the specimen show through from below. This process was

automated using built-in scripting tools available in Photoshop. The landmark area was

then colored using the Airbrush tool. Two-dimensional atlases were used as reference

and the physical specimen was often marked to ensure accuracy. The same procedure

was performed on each of the remaining thirty-five images. The process was repeated for

each of the landmarks on each of the specimens. Needless to say, this procedure was

very time-consuming. A total of 2,232 images were edited, taking approximately three

months to complete. Upon completion, the background image of the specimen was

erased and the landmark graphics exported as PNG files.

Specimen	Total images
Skeleton	360
Skull	396
Mandible	144
Scapula	180
Humerus	216
Radius	108
Ulna	180
Pelvis	216
Femur	252
Tibia	180
Total:	**2,232**

Table 3: Number of landmark images edited

PROPER PRONUNCIATION:

One of the major problems mentioned in the focus group discussion associated with learning anatomy is knowing how to correctly pronounce the terms used in the course. The anatomy terms have Latin roots, and are seen as a foreign language to most students. They are expected to use the terms on a daily basis once the reach their clinical rotations and it is important for them to be accurate and sound professional.

A professor from the veterinary technology program agreed to lend her voice and assist in the production of the narration. A Sony DVR-900 mini-DV camcorder with an external microphone was used to record the pronunciation of each landmark. The audio was imported via FireWire to Adobe Premiere 6.5 and then exported as a high-quality WAV audio file. Sound Forge 6.0 was used to edit the raw sound data into individual clips. These sound clips were incorporated into the final project prototype and were available to the users with the click of a button.

INTERFACE DESIGN:

Adobe Photoshop 6.0 was used to design and create the interface graphics. The goal was to create an interface that seamlessly tied all of the media types together. The interface must be attractive to the user, but must not distract them from what they need to learn. The interface created satisfies all of these requirements. It is visually attractive and binds the various media types together into one pleasant experience. It has places for the 3D specimens, the specimen list and the list of landmarks. It is very easy to navigate and little or no time is required to learn it.

ASSEMBLY IN MACROMEDIA FLASH:

The thirty-six JPG images comprising a specimen were imported into the Macromedia Flash timeline. Actionscript programming was used to monitor the user's mouse movements. The exact scripting used is available in Appendix G. If the mouse button was clicked and the mouse dragged, the specimen images will scroll. The

scrolling images give the user the impression that they are rotating the object. Each of the specimens and anatomical landmarks were transformed into an individual Flash file.

A separate Flash file was created to house the interface graphics and buttons. The "load external SWF" action was used to bring the specimen and landmark Flash files into the main program. This modular approach has several advantages. If the project is ever converted to a web-based format, this structure will allow the user to download specimens and landmarks only as they are needed. This will help to alleviate the problem of a lengthy initial download. It is also convenient for the designer, providing the ability to easily modify individual files or add future specimens and landmarks to the project.

PROTOTYPE ON CD-ROM

Three computers were used to complete the production process. The first was a Pentium III 1GHz running Windows 2000. This machine controlled the digital camera used for photographing the specimens. The second computer was a dual Pentium Xeon 350 MHz running Windows 2000. It controlled the Kaidan turntable and was used primarily for image editing. Finally, an AMD 1.2 GHz running Windows XP was used to assemble the media elements in Macromedia Flash MX and burn the final project prototype to CD-ROM.

The main Flash interface into which the other elements load was saved as a Flash Projector file. When using a projector, the user does not need any additional programs or plug-ins to view the material. This is very advantageous when the state of the user's

computer is unknown. It saves the user time and frustration from having to download

additional components before the program can be used. The CD-ROM was set to auto-

play upon insertion. If the user has this option enabled on their computer, the program

will launch immediately after the disc is placed in the drive. This option is very

convenient, but can be disabled via an option available through the operating system.

If this option is not enabled in the user's operating system, they will simply need to

double click on an icon in order to launch the program.

PROTOTYPE USABILITY TESTING

Upon completion of the prototype, a total of five participants were chosen to test

the project. All of the participants who volunteered were first year students enrolled in

the veterinary technology program at Michigan State University College of Veterinary

Medicine. The students possessed varying degrees of computer skills and were asked to

rate their own knowledge levels. One student identified herself as a novice, three as

moderately skilled and the final participant described herself as an advanced user. Prior

to the testing session, each volunteer signed a UCRIHS-approved consent form (see

appendix F).

The CD-ROM containing the project was loaded onto the Intel Xeon Workstation

for testing. Two synchronized digital video camcorders were placed near the

workstation. The first was aimed at the monitor to record the user's actions. The second

was aimed at the participant and recorded facial expressions and verbal feedback.

Each user was asked to accomplish a list of ten tasks (see appendix B) while using the program. The tasks included opening the program, navigating to specific specimens or landmarks and exiting the program. The participants were encouraged to explore the entire project and verbalize their thought processes, likes and dislikes. The author was present during each session but remained silent until the listed tasks were accomplished. Afterwards, considerable time was spent discussing ideas and options for improving the project.

USABILITY TESTING RESULTS

1. Executive Summary

The participants encountered few critical problems during the prototype testing sessions. The program took approximately five seconds to launch once the CD was inserted, which lead to concern among the users. All but one of the participants were unaware that the specimens could be rotated using the mouse. The subjects found the audio pronunciation helpful initially, but soon afterwards it began to irritate them.

2. Detailed Findings

The delayed launching of the program was confusing for the participants. Since no written instructions were included with the prototype, they had no idea what to expect after inserting the disc. There was a sense of relief when the program finally started, but the response often was "…is it supposed to do that?"

Four out of the five participants relied exclusively on the AutoSpin button to manipulate the specimens. They stated that the button was effective and from the author's perspective it did not appear to have a negative impact on their experiences. After the usability tasks were completed, the alternate method of rotating the specimens was revealed. The specimens only rotate when the mouse is dragged in the horizontal direction. Vertical movement causes no movement of the specimen, which was somewhat confusing to users dragging the mouse in a circular motion. Most found the click-and-drag method to be slightly awkward at first, but later claimed that it gave them more precise control over the specimen. The user could instantly rotate the sample to any position, rather than waiting for the AutoSpin function to arrive at that location. Most of the participants became very comfortable with the mouse method after two minutes or less of practice and used this method the majority of the time.

All of the participants found the audio pronunciation to be very appealing. A student first mentioned this idea during the focus group discussion. While it was initially helpful, the users found the audio to be somewhat irritating after a short period of time. Each time a landmark button was clicked, the area was highlighted on the sample and the term was pronounced. Once the student was comfortable verbalizing that term, they were no longer interested in hearing the narrator.

The majority of users immediately maximized the program to full screen mode after launch. When asked if they would like this to occur automatically, all responded

"no". There was a consensus that they would like control over the size and position of the program window with the option to resize it as they saw fit.

PROJECT REVISIONS

The usability testing sessions were very useful and helped to point out several areas in which the project was lacking. Revisions were made to the prototype based on the feedback received from the users. The goal was to make the project as complete and user-friendly as possible. Due to technical and time constraints, it was not possible to implement every suggestion. Ideas that would make the greatest positive impact were incorporated into the final version.

1. CD Label and Insert

A basic label was created to aid students in the correct placement of the disc in the CD-ROM drive. The blank CD's used for the prototype were unbranded and appeared metallic on both sides. This lead to considerable confusion among the participants.

The system requirements and instructions for launching the program were printed on the CD case insert. The program is designed to auto-run upon insertion, but this process may take up to ten seconds to complete. The majority of the participants appeared concerned when nothing happened immediately. This expected delay time was printed on the insert, along with instructions on how to launch the program if the auto-run option is disabled on the user's computer.

2. Operational instructions

The phrase "click and drag to rotate the specimens" was integrated into the user interface and also printed on the CD insert. This was done to clarify that the specimens can also be manipulated using the mouse, a fact that four of the five usability testing participants failed to notice. Although the specimens can be rotated using the AutoSpin buttons, most of the test subjects found using a combination of both control methods most beneficial.

3. Audio Pronunciation

A separate button was created to launch the pronunciation of each landmark name. Using this approach, the student hears the audio only if they are interested rather than having it read automatically each time a landmark is selected. This allows students to target specific terms that are troubling them and also minimizes the "annoyance factor".

CHANGES PLANNED FOR THE FUTURE

Several participants expressed interest in being able to rotate the specimens in more than one direction rather than being limited to rotation alone. This may be beneficial but would take a considerable amount of time to accomplish. This approach would require approximately 1296 pictures to achieve the desired effect. Alternative imaging techniques are discussed in the next chapter.

Users would like to see additional specimens such as the vertebral column and carpus (forepaw) included in the next version of the project. Participants suggested including an articulated forelimb and hindlimb to help them further comprehend spatial anatomical relationships. Acquiring, photographing and editing these additional specimens will take approximately three months time but could prove to be valuable additions to the project.

Finally, a brief animation or tutorial showcasing the program's capabilities would be helpful for the user. This material would not be visible each time the program was launched, but only when the user wanted additional information.

Chapter 7

CONCLUSIONS

After undergoing several revisions, the project managed to meet its objective of providing a fun and easy way for veterinary technology students to learn canine skeletal anatomy. Participants in the usability testing sessions stated that the program was easy to use and would be very beneficial to them in their courses. Most seemed amazed by the 3D and audio capabilities of the program and eagerly explored every section of the program. During the entire process, the users appeared to be having a genuinely good time.

After speaking with many people in the veterinary technology program, this type of program seems to be ideal for them. The vast majority of students are hands-on learners, but due to time and distance issues cannot always make it to the lab. The QuickTime VR-based technology is a well-suited substitute for this audience. Several students in the usability sessions commented that it felt just like they were holding and spinning the specimens in their hand as they rotated them using the mouse. This project succeeds in giving them an accurate and interactive 3D anatomy atlas available any time, any where.

Throughout the development of this project, the author learned a great deal about design research methods. It was exciting to apply concepts learned from didactic education to a real-life problem. Information obtained from focus group discussions and

usability testing sessions does have a considerable effect on the course of a media project. The author further explored the potential of Macromedia Flash and greatly expanded his knowledge of the Actionscript programming language.

In many ways, the project will never be complete. Technical issues and time constraints made some ideas impossible, but solutions may one day present themselves. There were many factors that limited the rate at which the project was developed. However, some of these may be avoidable in future endeavors to create the best resource possible for students.

TECHNICAL ISSUES

The majority of the production time was spent on solving two main technical issues: proper photographic technique for the specimens and simulating the layered QuickTime VR effect using Macromedia Flash.

It took several months of experimentation to develop a process to photograph the specimens in an accurate and efficient manner. The bones were bright white and oftentimes looked washed out in the final digital pictures. A variety of camera flash settings were attempted, along with fine adjustments of the camera exposure settings. An ideal solution was finally achieved using diffuse fluorescent lighting, compensatory camera exposure settings and no camera flash.

Approximately two weeks time was taken to perfect the programming used to achieve the QuickTime VR visual effect using Macromedia Flash Actionscript programming. The goal was to detect the user's mouse click and drag direction, and change the image of the specimen currently being viewed. QuickTime VR is basically just a series of still images that play in rapid succession according to the user's mouse movements to achieve the illusion of rotating an object. Simulating this type of illusion in Flash has several advantages. Most importantly, the virtual specimens can easily be integrated with other media types. Adding additional anatomical landmark image layers that could be enabled and disabled was straightforward and effective using Flash. Each landmark was self-contained in a separate SWF file, averaging 10KB in size. This has obvious advantages if the project is converted to a web-based format, especially for users with dialup connections. The landmarks can be downloaded as needed, without initially investing a large amount of download time.

Achieving an identical layered effect using standard QuickTime VR files and Live Stage Pro was very problematic and ultimately unsuccessful. Each picture series had to be added as a separate image track. QuickTime Player had considerable difficulties compositing these images on top of the primary VR object. It was not always effective in enabling or disabling the visibility of the layers. As a result, the landmark layers were often not rendered, or moved out of sync with the underlying specimen. The QuickTime VR file size was also much larger, since it had to contain every image for every landmark on the specimen. The user had to spend considerable time downloading this composited file before the specimen could even be viewed.

CONTENT ISSUES

Another bottleneck of the development process was the pain-staking process of coloring each anatomical landmark. For each landmark of each specimen, a total of thirty-six images had to be edited to achieve one complete rotation. Every area had to be thoroughly researched beforehand to ensure accuracy. The physical model was marked and used as a reference guide for the image editing. The results were spectacular, but the process was very time consuming.

THE STUDENT PERSPECTIVE

Based on interaction with students during the focus group discussion and usability testing sessions, it was apparent that this project would be very helpful to them. The initial "awe factor" of seeing sample digital specimens encouraged students to participate in the research process. All of the participants were very helpful and gave clear and honest input. Having veterinary technology students actively involved in the development process was ideal. Comments from students included "this is amazing…" and "thank you for doing this for us…"

The general feeling among participants was that this project would be beneficial to them in the future for their courses, clinical rotations, and even as a reference guide in the future when they are working in the field. Ironically, the usability testing sessions were conducted immediately following a midterm anatomy test. Several students wished they had access to the program before the test. It was convenient for prototype testing since the subject of anatomy was fresh on their minds. All of the volunteers stated that

they were having fun during the testing and were glad to take part in the development of the project.

FUTURE ENDEAVORS

There is much interest, both from the perspective of students and the author, in further developing this project. Research participants stated that they would like to see additional specimens such as the vertebral column included in next version. To make the project more applicable to other types of students, such as students in the Veterinary Program (DVM), additional anatomical landmarks may be added to the existing specimens.

There is also interest in creating a similar type of project for other species such as cats and horses. Students expressed interest in having a version that included several different species, with an option to compare the anatomy between them.

An initial focus will be to make the project web-based, which will allow even more people to have access to it. Certain issues will have to be taken into account, such as which plug-ins (Flash, QuickTime) are installed on the user's machine. Bandwidth constraints must also be considered. A version with lower quality images will be made available to users with low speed Internet connections.

Students also expressed interest in having the project quiz them as they work through it. Several stated that they would like to switch back and forth between a standard "atlas mode" and a computer controlled "quizzing mode". The program will highlight a specific anatomical landmark on a randomly selected specimen. The user will be able to rotate the specimen and view it from any angle. They will then be prompted to type in the name of the landmark that is displayed. They will lose credit if the landmark is spelled incorrectly. The results of the quiz can be for student self-assessment or stored in a database which will assign a score/grade to each student.

The QuickTime VR photo realistic approach works well for most specimens. For gross anatomy, this is a time and cost-effective approach. If the sample can be prepared and mounted, it can easily be photographed and digitized. Users are very impressed with the photo realistic appearance of the specimens. They are much more convincing than the oftentimes poorly textured volume renderings which are more commonly seen. The end product is always a single-row simulation. The user has the ability to rotate the object around one axis only. The object cannot be tilted in order to view the top and the bottom. To produce such a multiple-row object would require approximately 1296 still images to achieve a realistic effect. This would require a massive amount of production time and would generate a very large file.

In order to produce a higher quality virtual specimen with a greater sense of interactivity, an alternative approach must be used. One technique is to use laser scanners to create a three-dimensional mesh of the sample. This route is more expensive

and time-consuming due to the high cost and slow speed of the equipment. The mesh object can be manipulated and altered in a 3D program such as 3DS Max. The author has a great deal of creative license with this type of program and can easily change an object's color, texture and other visible features. By exporting the specimen as a Shockwave 3D object, the user will be able to rotate the object in multiple directions and view it from any angle. This approach will require the user to have a faster computer with a video accelerator card since the three-dimensional object and its textures will be rendered in real time.

Three-dimensional data can also be acquired from medical equipment such as computerized tomography (CT) and magnetic resonance imaging (MRI) systems. Based on tissue density, areas such as bones, muscles, veins and nerves can be isolated and enhanced. Both living and cadaver animals can be scanned. This technique yields an abundance of highly accurate data that can be used for three-dimensional reconstructions and interactive fly-throughs. However, it requires very expensive medical equipment and often costly proprietary image processing software. It is also incredibly time-consuming to identify each structure from the image slices that are generated.

QuickTime VR is a very powerful, yet often under-utilized, tool available to the medical profession. With the proper setup and basic photography skills, high-quality digital models can be inexpensively created from almost any object available. Students benefit greatly by having a valuable learning resource available to them anytime, anywhere.

Focus group discussion guide

Discussion Guide: Using QuickTime VR for Teaching Canine Skeletal Anatomy
Focus Group Interview
January 2003

1.) Introduction (5 minutes)

Greeting (moderator introduces self)

Purpose statement

"Your input during this discussion will help me to better design multimedia software that will benefit veterinary technology students."

Rules

Privacy and Confidentiality

Only your first names will be used. When writing up the results, your real first names will be replaced by fictitious ones. This interview will be audio taped. In the consent forms you filled out before the session, you gave me permission to use your responses in the project report. Unless you said yes to that question, your answers will remain confidential. Once the tapes have been analyzed, your name will no longer be associated with your responses in any of the written reports about the focus group interview.

No right or wrong answers

There are no right or wrong answers. I'd like to know what you honestly think and feel.

One person talks at a time

I would prefer if only one person speaks at a time. This will help to avoid confusion. Please speak as clearly as possible.

Moderator Role

I will be the moderator of the focus group discussion. My role will be to help keep the discussion on time and on task.

Introductions/ice breaker activity

Let's begin by going around the room and introducing ourselves. Please tell the group your first name and your year in the program.

2.) Past anatomy courses (10 minutes)

Describe your experiences in any previous anatomy courses you have taken. Were you satisfied with the curriculum? How easy or difficult is it to learn the material? How do you use what you learned in the clinical setting? How much knowledge have you retained?

3.) Lab resources, computer resources (10 minutes)

Describe your level of satisfaction with the laboratory and computer resources that were available to you. Describe the specimens that were available to help you learn. How often (if at all) did you use the computers that were available in the laboratory area?

On average, how many hours per week did you spend in the lab? Was the lab open frequently enough to suit your needs? Describe how you studied after the lab was closed.

4.) Computer skills, connectivity (10 minutes)

Do you have a computer at home? If so, please describe it (age, speed, etc). Describe your computer skills. Are you a beginner or advanced user? How often do you use computers?

Is your computer connected to the internet? How fast is your internet connection at home? Do computers play a role in your education? How? Do you use the internet for any of your courses?

5.) Improvements, benefits (10 minutes)

In your opinion, what (if anything) could be done to improve the anatomy course? Do you think this software will be useful to you and other students in the veterinary technology program? Why or why not? What would you really like to see the software do in order to help you learn? Do you think this software would be valuable to you at your current stage in your academic program or even after graduation? Would you purchase the software? If so, approximately how much would you spend on it?

Usability testing sessions task list

Usability Testing Task List

1. Start the program

2. Select the landmark on the skeleton called "humerus"

3. Rotate the skeleton 360 degrees

4. Select the specimen called "scapula" and rotate it

5. Select the landmark on the humerus called "head"

6. Turn AutoSpin to "on"

7. Select the specimen called "mandible"

8. Turn AutoSpin to "off"

9. Select the landmark on the mandible called "canine teeth"

10. Close the program

Focus group discussion advertisement flyer

- Research Opportunity -

Volunteers wanted for participation in a

Focus Group

exciting new 3D software for teaching canine anatomy

When: Friday January 24, 2003 at 12:00 pm
Where: VTH - Buchanan Room
Who: Students in the Veterinary Technology Program
Selection: The first <u>ten</u> people to reply will be selected

Please volunteer for 45 minutes and help to improve the project

All participants will receive:

       FREE Lunch
       FREE software on CD-ROM

For more information, please contact:

Robert Malinowski, DVM
(517) 353-9174
malino11@cvm.msu.edu

Usability testing sessions advertisement flyer

- Research Opportunity -

Volunteers wanted for participation in

Prototype Usability Testing

exciting new 3D software for teaching canine anatomy

When: Saturday February 22, 2003
Where: VTH – Information Technology Center
Who: Students in the Veterinary Technology Program
Selection: Looking for people with a range of computer
                   skills (beginner to advanced) to participate.
                   A total of five people will be selected.

Please volunteer for 30 minutes and help to improve the project

All participants will receive:
         $10 in cash
         FREE software on CD-ROM

For more information, please contact:

Robert Malinowski, DVM
(517) 353-9174
malino11@cvm.msu.edu

Focus group discussion consent form

Informed Consent to Participate in Human Subject Research

3D K9: Using QuickTime VR to Teach Canine Skeletal Anatomy

Principal Investigator: Secondary Investigator:

Brian Winn   Robert Malinowski, DVM
420 Communication Arts Bldg   A227 Veterinary Medical Center
East Lansing, MI 48824   East Lansing, MI 48824
(517) 353-5497   (517) 353-9174
winnb@msu.edu   malino11@cvm.msu.edu

Purpose of the Research

You are being asked to volunteer for a research project. Your experience as a student in
the veterinary technology program at Michigan State University is needed to assist in the
development of a multimedia learning tool for teaching canine skeletal anatomy. The
project will feature photorealistic models of canine bones that the user can manipulate
and view from any angle.

The first ten veterinary technology students who have expressed interest have been
invited to participate in the focus group discussion. It will involve less than one hour of
your time.

Procedures

A focus group discussion will be conducted at the Veterinary Medical Center. The
secondary investigator will serve as the discussion moderator and will help to keep the
discussion on time and on task. The discussion will be informal, giving you a chance to
express your feelings and opinions about your past anatomy courses, perspectives on
computers and technology and suggestions on how this portion of your education can be
improved. The structure of the discussion will be based upon a pre-formatted discussion
guide.

Foreseeable Risks or Discomforts

Participation in this research poses minimal risk to you. If you feel uncomfortable at any time during the focus group, you may immediately withdraw from the study with no questions asked. All efforts will be made to keep the focus group duration less than one hour to help protect you from fatigue.

Benefits

This research will give you the opportunity to assist in the development of a product that will be beneficial to yourself and others involved in your program of study.

Voluntary Participation/Withdrawal

Your participation in this focus group discussion is voluntary. You have rights as a research volunteer. If you do not take part, you will have no penalty. You may refuse to participate before the study begins, discontinue at any time, or skip any questions that may make you feel uncomfortable, with no penalty or loss of compensation earned before withdrawing.

You are allowed to ask questions concerning the study, both before agreeing to be involved and during the course of the research study.

Confidentiality

Your privacy will be protected to the maximum extent allowable by law. Your name will not be associated with the detailed findings. All original audio recordings will be kept in a locked desk drawer until digitized and transcribed. At this point, the originals will be destroyed. The data will be stored on a drive on a password-protected computer, available only to the investigators.

Compensation/Costs

For participating in the focus group discussion, you will receive a free lunch (pizza or subs) on the day of the research, as well as a copy of the completed project on CD-ROM.

Audio Recording

The discussion will be recorded on audiotape, which will be kept in the possession of the secondary investigator until the thesis is completed, at which time the tape will be erased. Only your first name will be used during the interview. When writing up results, real first names will be replaced by made up first names.

Contact Persons

If you have any questions about this study, please contact the principle investigator:

Brian Winn
420 Communication Arts Bldg
East Lansing, MI 48824
(517) 353-5497
winnb@msu.edu

If you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – Ashir Kumar, M.D., Chair of the University Committee on Research Involving Human Subjects (UCRIHS) by phone: (517) 355-2180, fax: (517) 432-4503, e-mail: ucrihs@msu.edu, or regular mail: 202 Olds Hall, East Lansing, MI 48824.

Statement of Consent

_____ I voluntarily agree to partic ipate in this study.

_____ I am willing to have this focus group interview recorded on audio tape.

_____ I consent to have my comments included in the written summary of the discussion.

Name: _____

Signature: _____

Date: _____

<u>You will receive a copy of the signed and dated consent form.</u>

Usability testing sessions consent form

Informed Consent to Participate in Human Subject Research

3D K9: Using QuickTime VR to Teach Canine Skeletal Anatomy

Principal Investigator: Secondary Investigator:

Brian Winn   Robert Malinowski, DVM
420 Communication Arts Bldg   A227 Veterinary Medical Center
East Lansing, MI 48824   East Lansing, MI 48824
(517) 353-5497   (517) 353-9174
winnb@msu.edu   malino11@cvm.msu.edu

Purpose of the Research

You are being asked to volunteer for a research project. Your experience as a student in the veterinary technology program at Michigan State University is needed to assist in the development of a multimedia learning tool for teaching canine skeletal anatomy. The project will feature photorealistic models of canine bones that the user can manipulate and view from any angle.

A total of five veterinary technology students will be invited to participate in the usability testing sessions. The testers will have a variety of computer skills, ranging from beginner to expert. The procedure will involve less than one hour of your time.

Procedures

A usability testing session will be conducted to observe you using the project prototype. You will be given a small number of simple, specific tasks to accomplish with the prototype. You will be asked to think aloud and voice any difficulties you are having. The session will be recorded using a video camera, with both the computer monitor and your facial expressions visible.

Foreseeable Risks or Discomforts

Participation in this research poses minimal risk to you. You may experience slight fatigue or frustration with the computer software. Short breaks will be allowed. If you feel uncomfortable at any time during the session, you may immediately withdraw from the study with no questions asked. All efforts will be made to keep the duration less than one hour to help protect you from fatigue.

Benefits

This research will give you the opportunity to assist in the development of a product that will be beneficial to yourself and others involved in your program of study.

Participation in the testing sessions will give you an opportunity to learn more about the canine skeletal system. You may enjoy the opportunity to imagine using this new learning tool in your studies and in your future careers.

Voluntary Participation/Withdrawal

Your participation in this testing session is voluntary. You have rights as a research volunteer. If you do not take part, you will have no penalty. You may refuse to participate before the study begins, discontinue at any time, or skip any questions that may make you feel uncomfortable, with no penalty or loss of compensation earned before withdrawing.

You are allowed to ask questions concerning the study, both before agreeing to be involved and during the course of the research study.

Confidentiality

Your privacy will be protected to the maximum extent allowable by law. Your name will not be associated with the detailed findings. All original audio and video recordings will be kept in a locked desk drawer until digitized and transcribed. At this point, the originals will be destroyed. The data will be stored on a drive on a password-protected computer, available only to the investigators.

Compensation/Costs

For participating in the usability testing session you will receive $10 for your time, along with a copy of the completed project on CD-ROM.

Audio and Video Recording

The session will be recorded on videotape, which will be kept in the possession of the secondary investigator until the thesis is completed, at which time the tape will be erased. When writing up results, first names will not be used.
Contact Persons

If you have any questions about this study, please contact the principle investigator:

Brian Winn
420 Communication Arts Bldg
East Lansing, MI 48824
(517) 353-5497
winnb@msu.edu

If you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – Ashir Kumar, M.D., Chair of the University Committee on Research Involving Human Subjects (UCRIHS) by phone: (517) 355-2180, fax: (517) 432-4503, e-mail: ucrihs@msu.edu, or regular mail: 202 Olds Hall, East Lansing, MI 48824.

Statement of Consent

_____ I voluntarily agree to participate in this study.

_____ I am willing to have this usability testing session recorded on video tape.

_____ I consent to have my comments included in the written summary of the session.

Name: _____

Signature: _____

Date: _____

You will receive a copy of the signed and dated consent form.

APPENDIX G

ActionScript for QuickTime VR effect in Flash

```
onClipEvent (load) {
        mouse = this._xmouse;
        mouseDrag = this._xmouse;
        dragging = false;
        movieWidth = this._width;
        movieCenter = 0;
        noOfFrames = this._totalFrames;
        currentFrame = this._currentFrame;
        gotoAndStop(getProperty("/specimen", _currentframe));
}
onClipEvent (enterFrame) {
        frameToGoto = currentFrame-Math.round(((mouseDrag-mouse)/10));
        if (hitTest(_root._xmouse, _root._ymouse, false)) {
                mouseDrag = this._xmouse;
                if (dragging) {
                        if (frameToGoto>=1 && frameToGoto<=noOfFrames) {
                                this.gotoAndStop(frameToGoto);
                        }
                        if (frameToGoto<1) {
                                frameToGoto += noOfFrames;
                                this.gotoAndStop(frameToGoto);
                        }
                        if (frameToGoto>noOfFrames) {
                                frameToGoto -= noOfFrames;
                                this.gotoAndStop(frameToGoto);
                        }
                }
        }
}
onClipEvent (mouseDown) {
        mouse = this._xmouse;
        if (hitTest(_root._xmouse, _root._ymouse, false)) {
                dragging = true;
        }
}
onClipEvent (mouseUp) {
        dragging = false;
        currentFrame = this._currentFrame;
}
```

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