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**MARSHALL SPACE FLIGHT CENTER  
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE**

**THE DEVELOPMENT, ASSESSMENT AND VALIDATION  
OF VIRTUAL REALITY FOR  
HUMAN ANATOMY INSTRUCTION**

**Prepared By:**

**Karen Benn Marshall, M.S.**

**Academic Rank:**

**Instructor/Director  
Allied Health Program**

**Institution and Department:**

**Oakwood College  
Department of Chemistry,  
Biochemistry & Allied Health**

**NASA/MSFC:**

**Laboratory:  
Division:  
Branch:**

**Mission Operations  
Operations Engineering  
Crew Systems Engineering**

**MSFC Colleague:**

**Joseph P. Hale**



## **INTRODUCTION**

Virtual reality is the computer graphics creation of an environment which allows its participants to physically interact with objects within an electronic environment. A virtual reality applications program has been under development at the Marshall Space Flight Center (MSFC) since 1989. The MSFC VR systems consist of VPL Research, Inc. EyePhones (Models 1 and LX), DataGloves and software (Swivel 3D, Body Electric and ISAAC), Polhemus Isotrak and Fastrak spatial tracking systems, two Macintosh IIfx computers and two Silicon Graphics Incl. graphics computers (4D/310VGX and 4D/320VGXB). In addition, MSFC is now utilizing WorldToolKit software. The objectives of the MSFC VR applications program are to develop, assess, validate and utilize VR in hardware development, operations development and support, mission operations training and science training.

This research project seeks to meet the objective of science training by developing, assessing, validating and utilizing VR as a human anatomy training medium. Current anatomy instruction is primarily in the form of lectures and usage of textbooks. In ideal situations, anatomic models, computer-based instruction, and cadaver dissection are utilized to augment traditional methods of instruction. At many institutions, lack of financial resources limits anatomy instruction to textbooks and lectures. However, human anatomy is three-dimensional, unlike the one-dimensional depiction found in textbooks and the two-dimensional depiction found on the computer. Virtual reality allows one to step through the computer screen into a 3-D artificial world.

The primary objective of this project is to produce a virtual reality application of the abdominopelvic region of a human cadaver that can be taken back to the classroom. The hypothesis is that an immersive learning environment affords quicker anatomic recognition and orientation and a greater level of retention in human anatomy instruction. The goal is to augment not replace traditional modes of instruction.

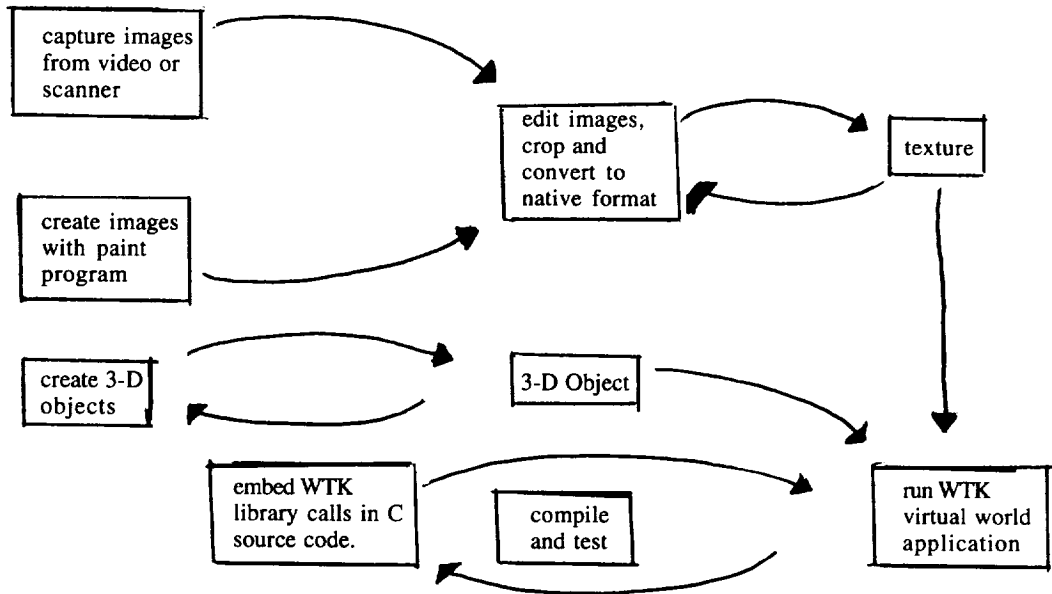
## **RESEARCH PLAN**

Previous work, in the summer of 1994, resulted in the creation of a static three-dimensional model of the abdominopelvic region of a human cadaver utilizing RB2 Swivel software, creation of the behavioral relationship between objects in the virtual environment via Body Electric software and establishment of the communications between the two software packages- RB2 Swivel and Body Electric. RB2 Swivel is a 3D modeling tool that runs on the Macintosh in which the appearance and structure of virtual worlds are built. Body Electric, which also runs on the Macintosh, brings the world to life by associating dynamic behaviors with the static Swivel objects. The software that renders the model in action is called Isaac. It runs on fast graphic computers, such as the Silicon Graphics. In real time, Body Electric modifies the whole condition of the world based on information from the physical world and internal process. Still in real-time (up to 30 times a second) Body Electric then sends the newly changed information to Isaac, which renders each object according to the updates received. By utilizing RB2 Swivel, the human body and the organs of the abdominopelvic region were created. These organs were the intestines, liver, gallbladder, stomach, spleen, pancreas, right kidney and left kidney. This 3-dimensional model is currently run on expensive graphic computers utilizing Polhemus Fastrak spatial tracking sensors.

This three-dimensional model has now been modified utilizing WorldToolKit (WTK) for Windows, a library of C functions. WTK has given considerable application

development power to the model. WTK allows the user to utilize an IBM compatible PC, head mounted display unit and joystick to interact with the virtual environment. This modification allows greater usability and will allow application usage in the classroom at a moderate cost.

The modification of the VR training medium consisted of hardware and software components of the WTK development system. These components included the host computer, WTK library, C compiler, RB2 Swivel, IPhoto Plus and 3D Studio software packages, standard mouse and joystick. With these components, one can do all the basic operations necessary to construct and use a virtual world application, including 3-D model creation, image or "texture" capture and editing, application development, and interaction with the finished program. This application development process was interactive and is shown below:



**Figure 1. WTK Application Development Process**

The 3-dimensional abdominopelvic organs and human body were created utilizing RB2 Swivel and 3D Studio software packages. Photo images of these organs were captured, edited and converted to native form utilizing IPhoto Plus Paint program. The 3-dimensional human body and organs were then loaded into the WorldToolkit Program for Windows as DXF files. WTK library calls were embedded in C source code. The information was compiled and tested. The 3-dimensional virtual reality human cadaver now runs utilizing the WTK virtual world application.

The VR application system as implemented will run on a Pentium PC. The commercial software required is WorldToolKit for Windows. WTK is platform independent and active in supporting new peripherals. In addition, WTK demos can be used to create virtual applications with very little modification. Currently, there are approximately twenty (20) demos on version 2.02. The C code language requirements are simple to master. Examples are included that one can easily cut and paste.

## **CONCLUSION**

In conclusion, the continued development, assessment and validation of virtual reality as a tool for human anatomy instruction will determine if and to what extent an artificial computer graphics simulation of the human body augments traditional modes of instruction. Modification of the current system using WTK has given considerable application development power and will allow greater usability of the model in the classroom at a moderate cost.

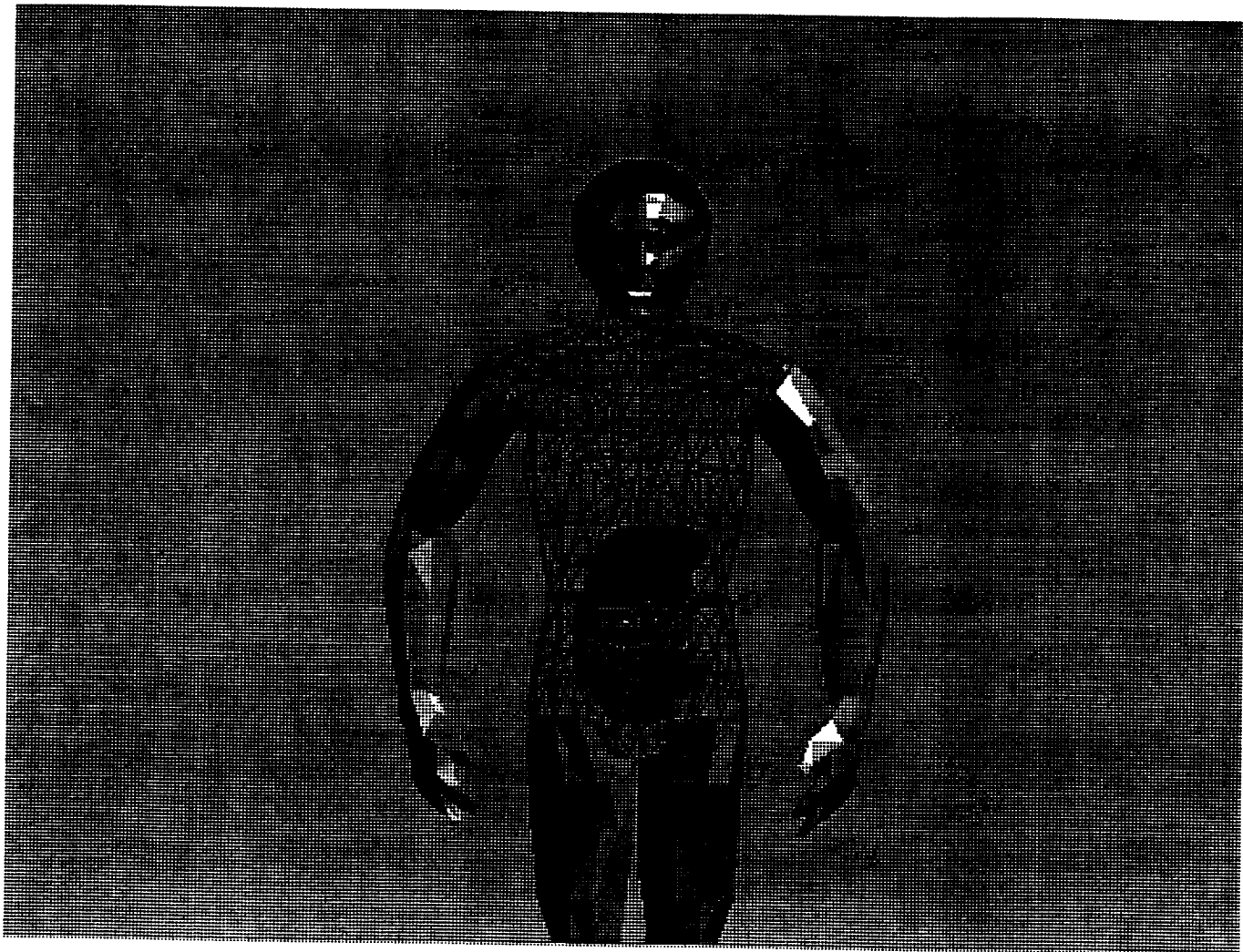
Future goals include the expansion of the human cadaver virtual reality model to include all organs, texture mapping, acoustics and haptic and forcefeedback.

## **ACKNOWLEDGEMENTS**

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**Figure 2 Virtual Cadaver**