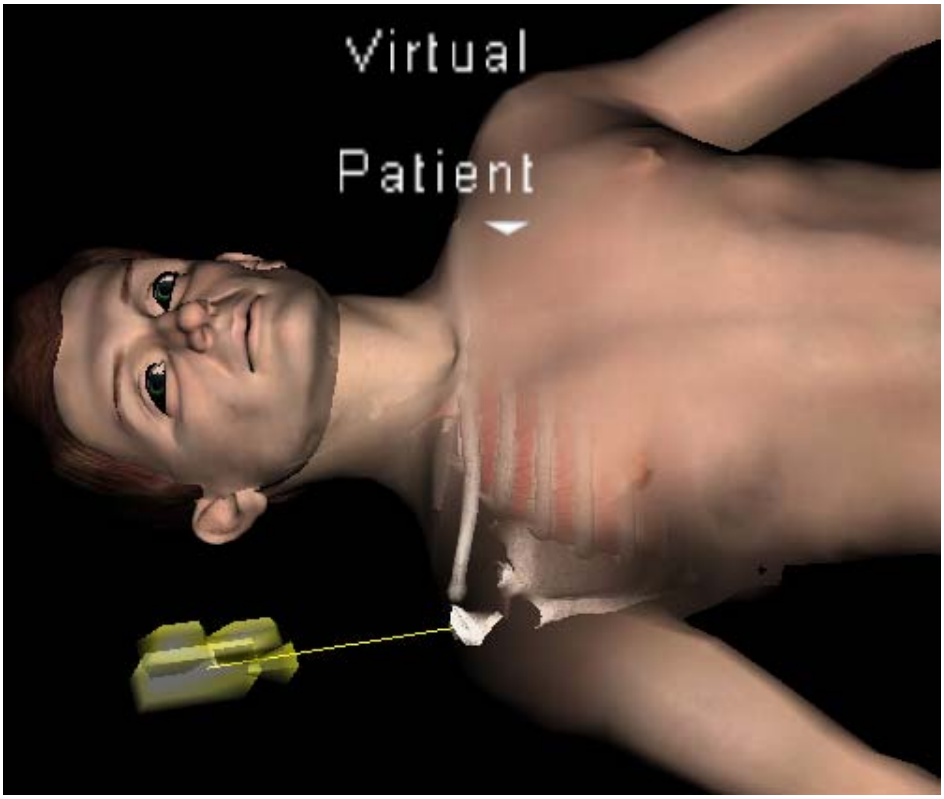
The Virtual Patient Project

www.tinkering.net/vp

Jean-Marc Gauthier, MPS, DPLG
Teacher, Interactive Telecommunications Program
Tisch School of the Arts New York University
jean-marc.gauthier@nyu.edu

Martin Nachbar, MD
Director, Advanced Educational Systems
School of Medicine New York University
nachbar@endeavor.med.nyu.edu

Funding for this research is provided in part by NYU's CDCF 2004-2005 grant.



This research project explores the convergence and synergy between computer games and medical visualization. Scientific and medical visualization is aligned with game technology in order to create content that illustrates changes in a body rather than a representing a body at one frozen moment in time.

Virtual simulators for professional medical training and education in the domain of cardiac sonography or laparoscopic surgery have long been a common application of virtual reality. When using live patients is unfeasible or unpractical, existing virtual reality applications based on visual and tactile interactions can recreate rare disorders or help to perform delicate or dangerous procedures. Virtual reality is currently used to explore the internal organ structure of the human body which can be viewed as an exploded view of a car engine. The virtual patient is built on top of a behavioral engine that can simulate the complex elements of the human body. For example, we focus on the interactions between physiologic systems and the rules governing those interactions. For instance, there is a connection between pain perception and the control of blood pressure such that "severe" sudden pain may cause someone to feint as excessive neuronal stimulation or discharge may lead to a dramatic slowing of the heart rate and an insufficient blood supply to the brain. The virtual patient belongs to the next generation of virtual reality applications inspired by video games, a genre that favors rules, behaviors, a more holistic approach of relationships between players and the virtual environment. The viewer can influence a system of relationships between organs instead of just viewing them as static models. Viewers can see on the same screen physiological data describing the event and its effect on the virtual body. The interface for the virtual patient allows several ways to view the same event.

This research is an attempt to understand the human body as whole, to integrate knowledge from different areas of medical expertise, to assemble and visually organize information. The virtual patient goes beyond the anatomic representations of the body. We resisted the temptation of focusing on body organs and systems viewed in isolation.

The enterprise concept for the virtual patient project is to provide an online real time visual interface that can create renderings of animated 3D models from data-crunching laboratories and medical departments. Physicians, radiologists, and laboratories own the data and we provide a dynamic visual interface at the end of a data processing pipeline. Our next step is to provide the appropriate plug-ins to parse and filter the client's most common data formats inside the web browser of choice. For example .tiff and Diacom files for radiology. The virtual patient setup will be available inside a web browser on the desktop, displaying on-demand high resolution renderings of a dynamic virtual patient. A subscription fee will let the user input data in real time on the virtual patient's web page.

The main contribution of this research is the behavioral engine inspired by game-play techniques that deeply engage players in rich multi-layered interactivity. The behavioral engine, currently being designed, is one step beyond interactivity. It can process inputs from the viewers and provides responses that are unique and unpredictable. We are developing the interactive design around the concept of the viewer influencing rather than controlling the virtual patient. The addition of artificial intelligence with path planning behaviors inside the virtual patient helps

to create physiological events that influence the viewer's decision making. We hope that this important element of the engine will improve the user's decision making skills in addition to his or her knowledge of the anatomy.

Description of the Virtual Patient

The current prototype is an animated 3D character controlled by a set of interactive tools. The viewer is able to see both the exterior and interior elements of the body. The viewer can change the position of cameras around the patient and select visualization tools from a 3D toolbox in order to display specific views of the body. The toolbox, visible in the following illustration, includes a navigation tool, an x-ray tool, a pin camera tool, a slicing tool, a cutting tool, a pealing tool, a storyline tool and a web tool.

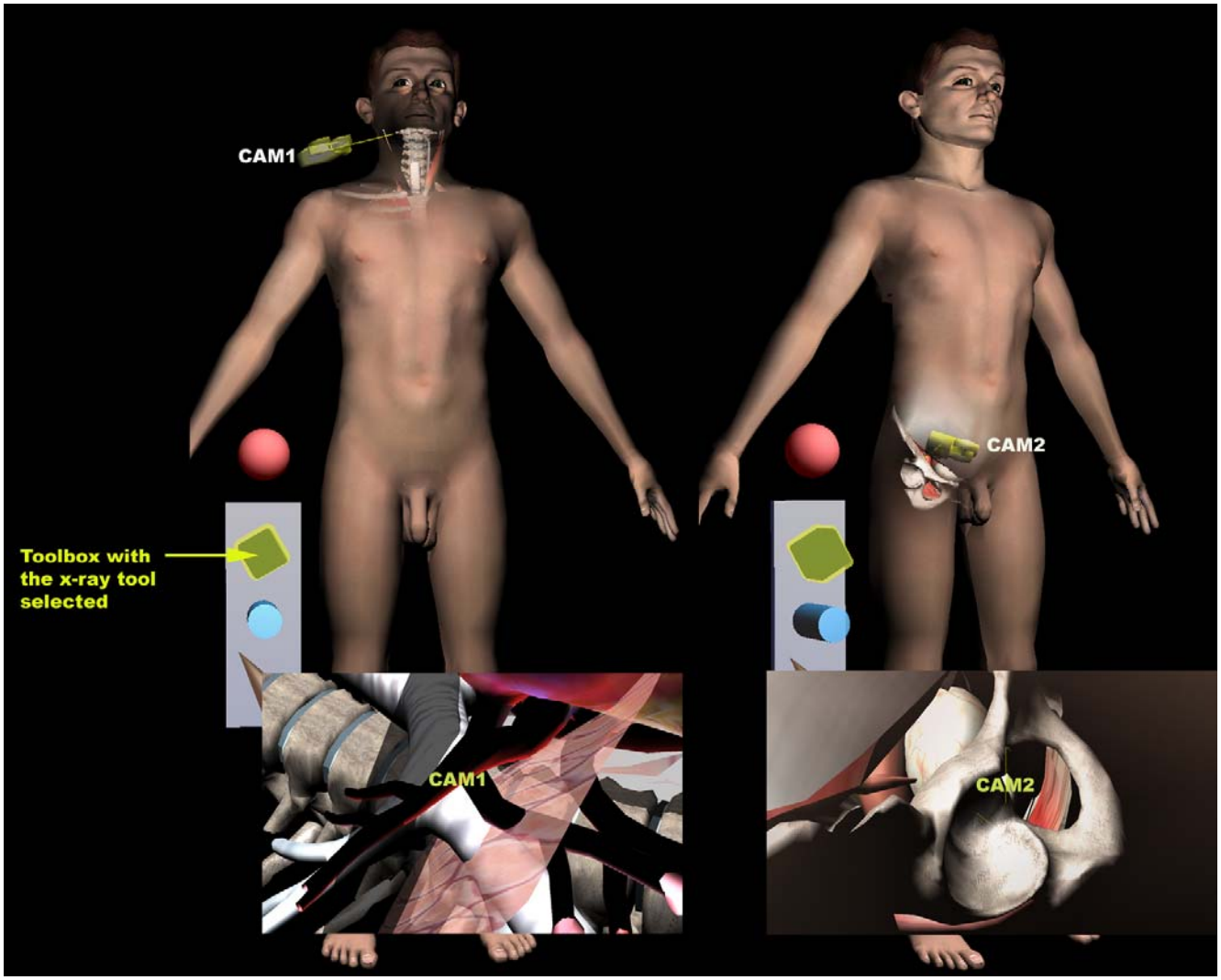


Illustration of the X-ray tool – identified by a 3D cube. This illustration presents the innovative "X-ray shader" technology created for this project. The following

image shows the floating toolbox with the 3D cube highlighted. Selecting the cube activates the yellow camera. A beam of light shines from the camera and touches the body. The area touched by the beam of light becomes transparent. Cameras are created by the viewer in various locations of the body. Each pin camera gives access to an enlarged view of a specific area of the body.

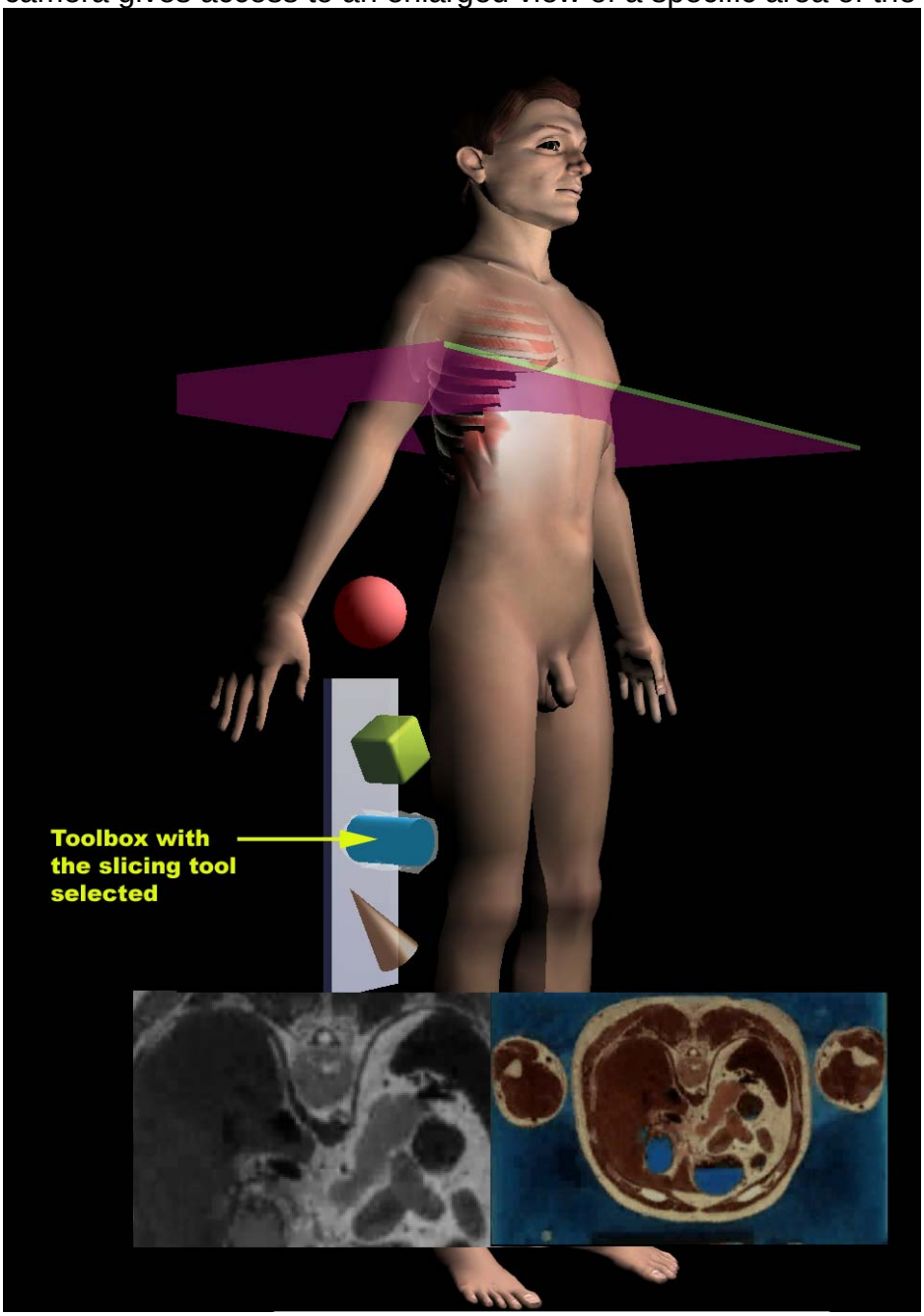


Illustration of the slicing tool – identified by a 3D cylinder. This illustration presents how to view interactive MRI slices of the virtual patient. This view shows a plane crossing the body and the images of cross section of the body shown in an additional window on the right side of the screen.

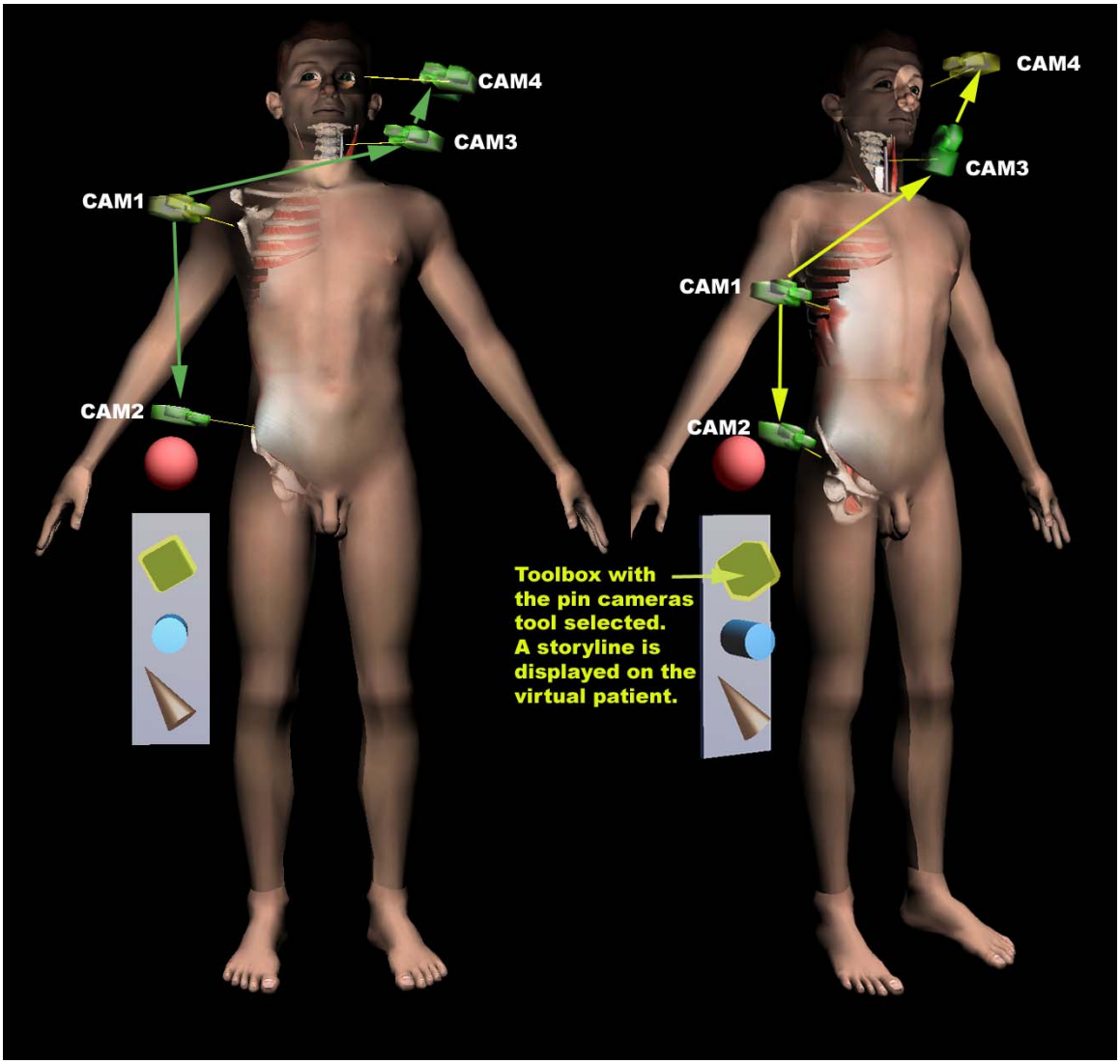


Illustration of the storyline tool. This illustration presents the concept of a path or storyline being recorded by the viewer. This view shows how to playback one storyline by connecting several pin cameras placed on the virtual patient. Views from the pin cameras and other visuals are placed in a chronological order inside a vertical a banner located on right the side of the screen.

Evaluation of the Virtual Patient project

We have carried out informal formative evaluations of our prototype during bi-monthly meetings at AES with various physicians from NYU School of Medicine. We have addressed and have worked with their comments for each new generation of the prototype. We witnessed reactions from two groups of people. The first group included physicians interested in expanding the use of computer visualization. They saw the virtual patient as a learning tool that gives the ability to integrate information in a non-textual way. For example a specialist in laparoscopic surgery of the Gall

Bladder was very receptive of the project. She found the virtual patient engaging for visualization and teaching three-dimensional locations of instruments inside the body. The computer visualization could complement the high-tech video technology used to view inside the body. A radiologist stated that the virtual patient could
be used “to make the abnormal more obvious”. The virtual patient can actually process and upload 3D models and 2D images. 3D models generated from CAT scans of the body and streams of images from MRI made of hundreds of thin slices of the body are paced in their exact location on the body of the virtual patient. The second group of physicians emphasized the need to look at the real patient rather than at a virtual patient. They warned us about the huge amount of complexity of the simulations and the risks of being toosimplistic. This group includes physicians using a higher level of computer technology in their daily practice. They warned us about the pitfalls of creating another tool in a medical environment already saturated with technology. They urged us to clarify the purpose of the Virtual Patient to determine if it was intended for teaching or for practice. To assist us in choosing which of these alternatives to pursue, we will broaden the formative evaluations to collect student perceptions of the project.

Thanks to the following people who collaborated on this project, Miro Kirov, Zach Rosen, Mike Olson, Marc Triola, Henry Feldman, Fabien Barati, Ganesh Ramanathan, Hillary Gauthier, Maria Mayer,