



MED SCHOOL 1.0:

Can Computer Simulation Aid Physician Training?

BY BOWEN LOFTIN

The public perception of medicine in the United States is one of high technology brought to bear on the diagnosis and treatment of disease. That perception is partially accurate, but it does not extend to the education and training of the medical practitioner. The Virginia Modeling, Analysis and Simulation Center (VMASC), one of Old Dominion's Enterprise Centers within the University's College of Engineering and Technology, in collaboration with Eastern Virginia Medical School (EVMS) and other organizations, is involved in enabling the use of modeling and simulation technologies in the production of the next generation of doctors, nurses and other medical professionals.

“See one, do one, teach one”: This simple set of phrases has characterized medical education and training for over 4,000 years. Today's physician is largely the product of an apprenticeship program that uses patients in hospitals as the primary elements of the “classroom.” Little changed in the past century to affect this traditional process. During this same century, however, we saw both the invention of the airplane and the maturation of flight simulation as the primary training tool for the aviator. Today, every commercial pilot masters a new aircraft in simulation. We have reached the point where the best flight simulators are virtually indistinguishable from the real thing. VMASC and its partners are committed to moving the field of medical education and training into at least the 20th century equivalent of flight training — and, hopefully, beyond.

The foundations of medical modeling and simulation have been laid down over the past 30 years. A major impetus in transferring modeling and simulation technology to the medical field has been the U.S. military. During the Gulf War, Col. Richard Satava, MD, realized that many of the medical personnel under his command — largely reservists recalled from their civilian practices for the war — had little recent experience treating the type of casualties typically found in war. Fortunately, the Gulf War was an almost bloodless one for the United States. Col. Satava, however, returned home convinced that the same approach to training fighter pilots and tank crews for the Gulf War should be adapted to training (and refreshing) military medical personnel. Ultimately, the Defense Advanced Research Projects Agency and, more recently, the U.S. Army Medical Research and Materiel Command developed extensive programs to create the needed technologies.

Transforming Medical Study

During 2001, VMASC and EVMS established the National Center for Collaboration in Medical Modeling and Simulation. The center was officially named by the 107th Congress as part of the 2002 Defense Appropriations Bill. Other partners include the Naval Medical Center Portsmouth and the Uniformed Services University of the Health Sciences.

The ultimate goal of this new center is to completely transform the way in which medical personnel are educated and trained. We envision the day when a medical student interviews a “virtual” patient and proceeds to perform a physical examination of that patient. The virtual patient — a single example of a large range of human anatomical and physiological variability — will nevertheless replicate the many injuries and diseases that the student should encounter while training. The availability of this approach to medical instruction will reduce, if not eliminate, the need for animal models and real patients that are the basis for preparing today’s medical professionals.

The starting point for our development of medical modeling and simulation is the creation of models of human anatomy. During the 1990s, the National Library of Medicine established the Visible Human Project, an effort to digitize a complete human male and female. To accomplish this task, a male and a female cadaver were acquired, completely scanned via X-ray and Magnetic Resonance Imaging, and then frozen. The frozen bodies were then thinly sliced, from head to toe, and the slices carefully photographed in high resolution. The resulting images were used to assemble three-dimensional models of both cadavers. Finally, anatomists carefully classified the different tissues, organs and structures in each of the two bodies. These two datasets are



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publicly available and have been incorporated into many products for anatomical study.

Much, however, remains to be done. These two subjects are but two examples representing a vast range of human size and anatomical differences, and yet have taken millions of dollars and many years of work to produce. VMASC has, for a number of years, been developing methods to accelerate and, ultimately, automate the generation of three-dimensional models of human anatomy from patient-specific data. Once these techniques are in place, the production of the many hundreds of models needed for medical training will be significantly faster and cheaper.

Judging Competency

An anatomical model is only the beginning. We must also model the physiological behavior of the anatomy so that disease and injuries can be accurately depicted and so that a physical examination of the anatomy can be supported. In other words, the student must be able to prod, pull, puncture, cut and squeeze the tissues. This is an extremely difficult task because each of our tissue types can behave very differently.

Consider, for example, the difference between skin and bone. Today, we can build physics-based models that can produce “real” behavior, but these models cannot be computed quickly. Clearly, when these models are used for training, they must be able to respond to stimuli immediately. In order to accomplish this “real time” response, VMASC has been developing hybrid models that use both physics and empirical data from real tissues in order to accurately produce a simulacrum of physical reality.

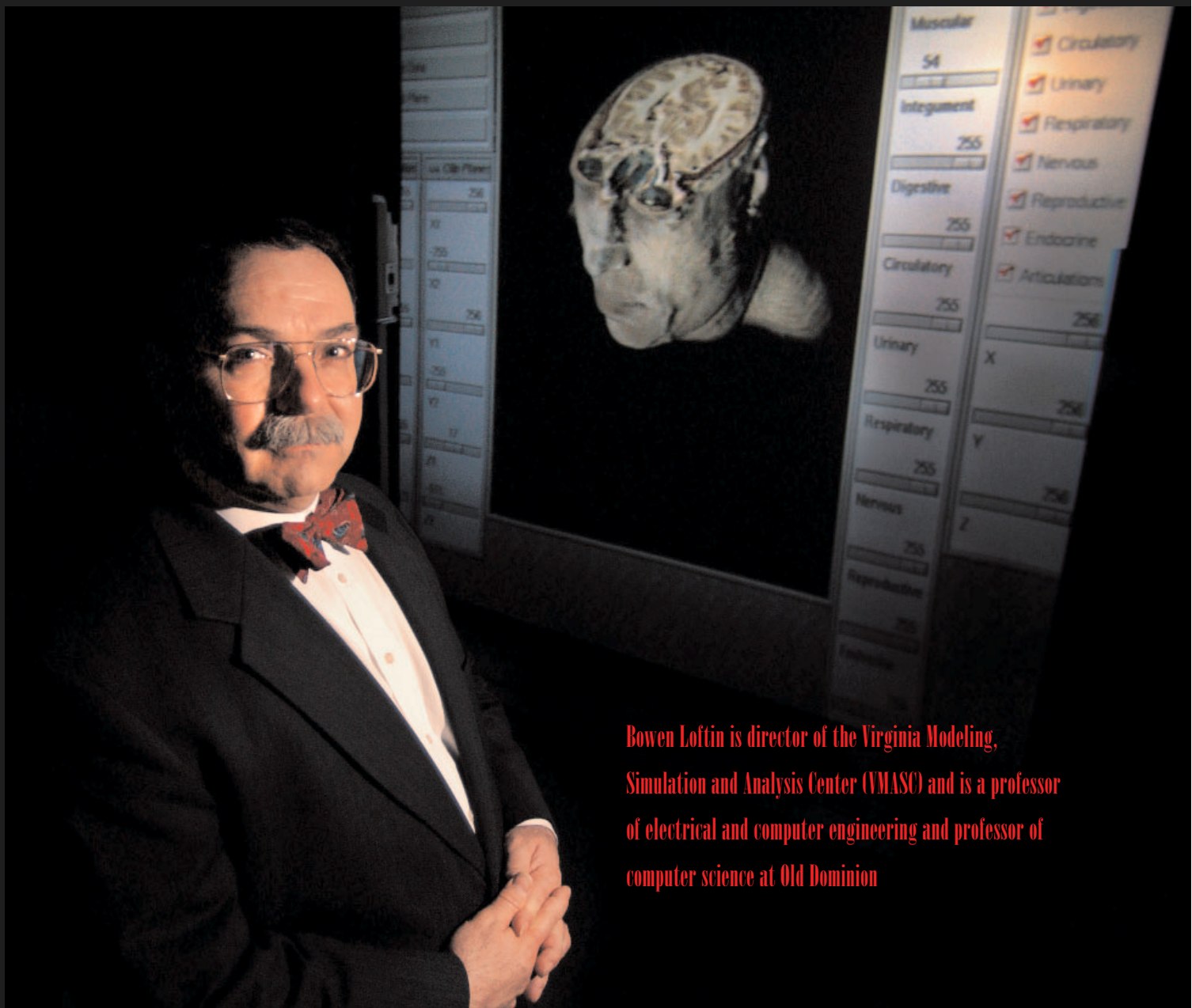
VMASC has also undertaken the assembly of these models into complete simulations. This step involves the integration of software with hardware that provides three-

dimensional visual displays, the ability to touch and feel the models, and interfaces for communication between the simulator and the trainee. Such interfaces include not only typical computer menus, but also interaction through the recognition and production of speech. Finally, and perhaps most importantly, we must evaluate the true utility of these simulations in performing training.

Will students using these simulations be equipped as well as or better than students using animal models and real patients for training? To answer this question, Old Dominion faculty from the Department of Psychology have joined the VMASC team and will work with both medical students and residents at EVMS, the Naval Medical Center

Portsmouth and the Uniformed Services University of the Health Sciences. The physicians from these institutions will be the final judges of the degree to which the simulations are successful.

The new center formed by VMASC and EVMS is assuming a leadership role in transforming medical training from its centuries-old reliance on apprenticeship training to one based, in large measure, on modern modeling and simulation technologies. We are convinced that this transformation will result in significant improvements in the quality of and access to health care in the 21st century.



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