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**GROWING THE MEDICAL AND HEALTH CARE  
MODELING AND SIMULATION INDUSTRY**

by

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**Introduction**

This white paper addresses the current opportunity to exploit a growing market for medical and health care modeling and simulation. Philosophers and historians have long noted that times of change and crisis are also times of great opportunity. We are in the midst of such a time now in Hampton Roads. One of the exciting additions to the region's economy during the past fifteen years has been the advent of a substantial modeling and simulation (M&S) industry. Consideration of the prospects for growing that industry, and thereby the proportion of highly paid scientists and technicians in the regional workforce, has become a focus of economic development planning and of some public investment. A catalyst for that growth and planning has been the U.S. Joint Forces Command (JFCOM). The net result of JFCOM's presence in the region is a substantial cadre of highly trained and highly paid workers. Capturing and building on the intellectual capital of those workers is an urgent priority.

**Background on Medical and Health Care Modeling and Simulation**

The health care system in the United States is generally characterized as the most expensive in the world. Additionally, on a variety of measures, the system needs improvement. For example, it does not adequately provide prevention services; the manner and cost of the care provided varies inexplicably across the country; and the safety of the services provided is less than optimal.

Using one of these issues as an example, several studies have documented that the U.S. health care system is not as safe as it should be. For instance, a study of Medicare data collected from over 5,000 hospitals across all 50 states from 2003-2005 was analyzed by the HealthGrades organization (2007). The study found that 284,798 patients had died from safety incidents (e.g., failure to rescue, foreign bodies left during a procedure, infections due to medical care, etc.) with an estimated cost of \$8.6 billion. More than 85% of those deaths were deemed to be preventable. Research has shown that improper use of equipment and instruments, the ergonomic design of equipment, individual performance, team and group behavior, organizational practices, legal and regulatory constraints, and societal and cultural pressures all contribute to errors in the health care system (Bogner, 1994; Kohn et.al. 2000). Further, the Accreditation Council for Graduate Medical Education (ACGME), the organization that accredits graduate medical education programs in the U.S., continues to require reduced working hours for medical residents (those physicians in graduate training to become surgeons, internists, pediatricians, etc.).

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These restrictions have raised new concerns about how to provide adequate training opportunities for medical residents within the available time.

In many high-risk occupations (e.g., aviation, military operations, and nuclear power plant operations), simulations have been widely used. For at least the last three decades, computer-based simulators have been a fundamental component of training in these industries. Not only do simulators provide a safe environment for trainees to acquire skills, but they also facilitate our understanding of human performance by providing more detailed and useful metrics than are provided by the traditional apprenticeship approach to medical and health professions training.

By contrast, simulations in the health industry have only begun to be more widely used during the past fifteen years, and computer-based simulator systems for training healthcare providers have only been generally available for the last ten years. However, the number and variety of medical simulator systems are now increasing rapidly. These new simulator-based training systems offer many advantages. They enable trainees to learn fundamental procedures without putting patients at risk. They allow greater opportunities for training to be matched to individual needs. And they can expose trainees to rare or unusual conditions, which they might not otherwise encounter in the training years. They reduce the need for using cadavers and animals in training. Moreover, evidence is beginning to demonstrate that clinicians who train using simulations are subsequently more skillful when they first perform procedures on living patients. Consequently, a growing number of residency review committees and licensing/certification bodies, such as the American College of Surgeons, are now considering how to use simulation for assessment and certification. Several quotes from the literature on training and education in the health industry illustrate the point.

*The Committee believes that health care organizations should establish team-training programs for personnel in critical care areas (e.g., the emergency department, intensive care unit, operating room) using proven methods such as the crew resource management techniques employed in aviation, including simulation.* – Kohn, et al. **To Err is Human: Building a Safer Health System**, Institute of Medicine, 2000.

*Medical training must at some point use live patients to hone the skills of health professionals. At the same time there is an obligation to provide optimal treatment to insure patient safety and well-being... The use of simulation wherever feasible conveys a critical educational and ethical message to all: patients are to be protected whenever possible and they are not commodities to be used as a convenience of training.* – Amatai Ziv, et al. **Simulation-based Medical Education: An Ethical Imperative**, *Academic Medicine*, 2003 Aug; 78(8): 783-8.

*Traditional training methods for new [medical and surgical] procedures include performing the procedure on animals, cadavers, or mechanical models*

*or supervised performance of the procedure on patients. Inherent problems with these traditional training strategies include the ethical and anatomical problems of training on animals, risks posed with repeated exposure to radiation, and the expense of consuming real medical devices.* – Gallagher and Cates, **Approval of Virtual Reality Training for Carotid Stenting, JAMA.** 2004: 292:3024-3026.

*At a public meeting in April 2004, an FDA panel voted to accept a proposal that virtual reality simulation would be an important component of a training package for carotid stenting... Trainees would learn catheter and wire handling skills on a high-fidelity virtual reality simulator until the trainees achieved a level of proficiency in didactic and technical skills.* – Gallagher and Cates, **Approval of Virtual Reality Training for Carotid Stenting, JAMA.** 2004: 292:3024-3026.

### **The National Center for Collaboration in Medical Modeling and Simulation**

Recognizing that simulation could help the health care industry respond to substantial training, quality, and patient safety issues, Eastern Virginia Medical School (EVMS) and Old Dominion University (ODU), through its Virginia Modeling Analysis and Simulation Center (VMASC), established the National Center for Collaboration in Medical Modeling and Simulation (NCCMMS) in 2001. NCCMMS was recognized as a national center in the 2002 Defense Appropriation Act and has operated with a mix of public and private funding since that time. In nine years of operation, it has conducted research and deployed simulation-based training systems designed to improve practitioner competence and patient safety. The collaboration has brought together academia, industry and the public sector. It is now time to take advantage of NCCMMS's successful research and development efforts and to operate as a national entity. Partnering with industry (both simulation and health care), accreditation and licensing organizations, and other academic partners, our goal is to establish the Center as a national leader in the use and study of simulation in health care delivery and training.

The vision is to establish NCCMMS as a national leader in fostering collaboration and using simulation to improve health care. To achieve this vision will require a committed partnership among academic institutions, the health care and simulation industries, and the public sector at all levels. NCCMMS's mission is to:

1. Develop simulation-based technologies for medical and health care training. These training advances will foster greater student throughput, address patient safety issues, and assist in certifying medical and health care professionals in new procedures and recertifying them on a periodic basis.
2. Develop simulation-based technologies to improve patient care.
3. Develop and employ medical M&S standards to foster cost effective products and prevent duplication.

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4. Collaborate with medical and health care licensing bodies on the proper use of simulation in teaching, training, and certification.
5. Develop a cadre of trained medical and health care simulation specialists.

Since its inception, the NCCMMS has received financial support from both public and private sources and has conducted research, produced intellectual property, and published over 100 research articles and presentations.

Senator John Warner and Congressman Edward Schrock worked to obtain an initial federal investment of \$3.4 million from 2002 to 2004. Then Governor Mark Warner and the Virginia General Assembly provided annual appropriations to NCCMMS of \$1.2 million. Congressman Randy Forbes worked to establish the Congressional Modeling and Simulation Caucus and has hosted several Simulation Summits, bringing together regional, state, and national leaders in the field. After Governor Warner was elected to the U.S. Senate, he formed the Senator Warner Modeling and Simulation Task Force, composed of industry and academic members, to continue planning for the growth of simulation in the region.

Unfortunately, the effects of the recession have dramatically reduced the public core funding of the NCCMMS to zero federal funds since 2004 and about \$400,000 in ongoing annual state support. These state funds are important to support ongoing research and development but are inadequate to support the type of major regional effort described in this white paper.

The NCCMMS has cooperated with industry to establish the annual MODSIM World conferences (one locally and one in Canada) and with the American College of Surgeons to establish the Medical Modeling and Simulation Database, which serves as the world's most comprehensive collection of research references on medical modeling. The research and development activities of the NCCMMS include projects addressing proteomic modeling, infectious disease, heart and lung sound emulation, maternal/fetal heart rate tracing, rehabilitation of hearing loss, stroke, and PTSD patients, homeland security, emergency training and response, gaming simulations, sonography, and virtual online and cellular phone-based training platforms.

What the NCCMMS has not yet done, largely due to the uncertain fluctuation of public core support is to achieve its national goals by broadening its board membership and securing substantial, ongoing core public investments of the magnitude to leverage substantial industry development and workforce growth. It is useful to note here that regional organizations that have been successful in building a productive medical M&S industry have generally received more than \$10M annually in core public support (e.g., the Center for Integration of Medicine and Innovative Technology (CIMIT), the Orlando partnerships).

Developing an expanded regional partnership among academia, government and the health care and simulation industries, building on the substantial success in regional M&S activities, and moving forward with urgency is what has worked in other

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regions and could work in Hampton Roads.

## **A Way Forward**

During the past two years, two important regional planning efforts have addressed parts of these challenges in two documents—VMASC's *Hampton Roads M & S Strategy 2020* (<http://www.hrp.org/Site/docs/ResourceLibrary/MS2010.pdf>) and the Hampton Roads Partnership's (HRP) *Vision Hampton Roads* (<http://VisionHamptonRoads.com>).

Both of these documents provide a framework for regional collaboration targeted toward modeling and simulation as a driver of economic growth. What is needed now is a specific effort addressing the opportunities in medical and health care modeling and simulation. This effort should be conducted under the overall auspices of the HRP and should involve representatives of academic institutions, the health care industry, the simulation industry, and economic development organizations.

The region is ripe for a sustained effort to maintain and grow the modeling and simulation sector of its economy. The Hampton Roads region has:

- Credible academic, industrial and legislative expertise in M&S;
- A strong history of collaboration in the region around M&S activities;
- A record of success in medical modeling and simulation despite limited funding, limited infrastructure, and a lack of substantial and sustained core public funding;
- The nation's only academic institution providing bachelor, master's, and doctoral level degrees in M&S at ODU;
- One of the nation's premier and longest-standing M&S research centers in ODU's VMASC;
- Recent significant medical M&S infrastructure improvements with the opening of the Tidewater Community College Regional Health Professions Center and the EVMS Simulation Center that will open in July 2011, both of which are capable of serving as international test beds for simulation training and research;
- An established track record in productive research and development in medical M&S with patents pending and a licensed product;

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- A nationally recognized Center of Excellence in human patient simulation utilizing standardized patients at the Theresa A. Thomas Center for Professional Skills Teaching and Assessment at EVMS;
- An established M&S business incubator effort at ODU-VMASC that has been successful in both attracting M&S companies to relocate to Hampton Roads and in providing support for local entrepreneurs interested in starting new M&S companies.

What is needed now is for the HRP to establish a single, integrated group consisting of representatives from academia, industry, and government that is charged to focus on the medical M&S opportunity for Hampton Roads. The group should work with the NCCMMS leadership and the members of the Senator Warner Simulation Task Force to:

- Conduct a facilitated strategic planning process for medical M&S and provide a detailed roadmap going forward that leverages the existing regional and national M&S infrastructure and expertise in the region and provides guidance for the appropriate use of additional investment and incentives for developing medical M&S.
- Engage a consultant to provide a marketing analysis of the opportunities for expanding medical M&S products and services and to identify specific opportunities for Hampton Roads medical M&S participants.
- Work with regional, state and federal officials to create a pool of core public funding, an “Innovation Pool”, of perhaps \$20 million over 4 years, to help support collaborative medical M&S research and development efforts within the region. The pool would be used as a source of matching funds on a 50/50 basis to resources provided by industry to help spur these research efforts. (The CIMIT consortium in Boston/Cambridge has benefitted from a combined investment of over \$10 million annually from government and its collaborative institutions for a decade to spur medical M&S research and development efforts.)
- Establish the NCCMMS as a medical M&S Center of Excellence in assessing medical simulators to include developing performance metrics and verification and validation processes. Possibly develop an “Underwriters Laboratory” for the evaluation of medical simulators.
- Strengthen business incubator and accelerator services provided by ODU-VMASC to attract medical M&S companies to the Hampton Roads region and to encourage medical M&S entrepreneurship.

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- Establish national test beds for medical simulation and training at the new EVMS and TCC medical simulation centers under the auspices of the NCCMMS.
- Closely monitor the economic development efforts of other U.S. regions that are seeking to move into the medical M&S space.
- Create an environment that promotes research, development, and commercialization of medical M&S technology and products by government, academic, and industry organizations.

In order for this way forward to be productive, HRP must proceed with urgency and focus and follow an aggressive timeline. The work already done by the HRP, the NCCMMS, VMASC, and the Warner Simulation Task Force should make the following initial timeline possible:

1. Designation of an HRP planning group (perhaps designating and expanding the existing Healthcare Opportunities Group): December 1, 2010;
2. Presentation of a focused plan on medical modeling and simulation: March 31, 2011;
3. Begin implementation in cooperation with regional, state and federal officials: May 1, 2011.

## REFERENCES

Bogner, M. S. (Ed.). (1994). *Human error in medicine*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Eastern Virginia Medical School (EVMS). [www.evms.edu](http://www.evms.edu)

Gallagher, A. G., & Cates, C. U. (2004). Approval of virtual reality training for carotid stenting. *JAMA*, 292, 3024-3026.

Health Grades, Inc. (2007, April). *Fourth annual patient safety in American hospitals study, April 2007*. Golden, CO: Author.

Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (Eds.). (2000). *To err is human: Building a safer health system*. Washington, DC: Institute of Medicine, Committee on Quality of Health Care in America.

National Center for Collaboration in Medical Modeling and Simulation (NCCMMS) <http://www.evms.edu/departments-research/national-center-for-collaboration-in-medical-modeling-simulation.html>

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Old Dominion University (ODU). [www.odu.edu](http://www.odu.edu)

Virginia Modeling, Analysis and Simulation Center (VMASC). [www.vmasc.odu.edu](http://www.vmasc.odu.edu)

Ziv, A., Wolpe, P. R., Small, S., & Glick, S. (2003). Simulation-based medical education: An ethical imperative. *Academic Medicine*, 78, 783-788.