This past year saw several new initiatives for VMASC research. In addition to the four already established applied research areas of military, homeland security, medical, and transportation we added three new areas based on emerging trends. The first of these areas is big data. With the vast amounts of data being generated every day it is very difficult for us humans to use this information in a productive manner to make decisions. However, simulation can utilize this information to add insight into choices to be made. As an example we used data feeds from cell phones, social media, and population information to simulate the optimum placement of critical care facilities within a country. Without simulation we could not have processed this amount of data to come up with the best placement.

The second area we added was cyber security. Clearly with this topic being in the headlines on almost a daily basis it is one that simulation can play a major role. We are partners with Norfolk State University and Tennessee State University on a cyber-security center of excellence. We are investigating ways simulation can help better understand the magnitude of threats and then test our appropriate mitigation techniques to help lessen this significant threat both from a government perspective and from a private industry view.

The third area we added was bio-engineering simulation. In the not too distant future each one of us will have a virtual representation against which a doctor can test out various prescriptions to gauge their effectiveness. Medical professionals will be able to accomplish drug trials without using actual humans. To get to this level of sophistication more detailed models of human systems need to be developed. We are devoting resources to the development of these models to further this vision of healthcare.

We continue to diversify our funding sources. We have added several new funding partners this past year including the Office of Housing and Urban Development (HUD), National Institute of Standards (NIST), and local governments. Entities outside the Department of Defense are now starting to see the value of M&S and are seeking our expertise in helping them solve the pressing problems they are facing. They are also hiring our graduates to help them employ the simulation tools that have been developed for their particular needs.

As you can see we have had a busy year. We look forward to the growth of the above initiatives as modeling and simulation continues its move forward as both a profession and academic discipline.

John Sokolowski
VMASC Executive Director
News and Events
July 2014 – June 2015

July/August 2014 and June 2015

VMASC Summer Game and Robotics Camps

Another successful summer under the instruction of Research Professor, Dr. Yiannis Papelis, Sr. Project Scientist's Hector Garcia and Menion Croll, VMASC continued its support of STEM education by providing five week long camps in Robotics, 3D Modeling and Unity Game Development. Computer literacy and STEM (Science, Technology, Engineering, and Math) are at the forefront of today's educational initiatives. Both have the potential of making individuals, young and old, participants of the ongoing technological revolution by opening the doors to entrepreneurship and well-paid job opportunities. The increased presence of social media, mobile applications, and mobile devices have made computing ubiquitous and computer programming a desirable and sought-after skill that can be applied in any field where computers are used. STEM has been and will be the driving force behind ocean and space exploration, advanced manufacturing, robotics, biotechnology, and transportation to mention a few. STEM education is also considered crucial as reported by the National Science Foundation's National Science Board in 2007.

One approach to increasing K-12 exposure to STEM principles and applications is through modeling and simulation (M&S). M&S provides the means to capture a real or imaginary system in a computer and ask questions about that system. M&S helps develop the ability to 1) meaningfully simplify a complex problem; 2) capture the problem in a model; 3) describe the model in a computer language, 4) collect meaningful input data; 5) execute the model over time; 6) obtain and analyze results and 7) make inferences about a potential solution to the problem. Further, models and simulations expose students to mathematics, logic, probability and statistics as well as help develop critical problem solving and analytical skills.

We at VMASC believe that one of the best ways demonstrate our commitment to advancing the discipline and practice of modeling and simulation is by extending our reach to enrich the education of our youngest minds. We undertake this valuable task by engaging with educators in our community and by providing students with hands-on programs and multiple specialized experiences throughout the year.
August 2014

Army Capabilities Integration Center (ARCIC)

Assistant Research Professor, Dr. Saikou Diallo, Senior Project Scientist's Christopher Lynch, Anthony Barraco, William Richards and Project Scientist, David Flanagan supported a ARCIC whereby the primary function was to support the execution of the game and the examination of the scenario by executing simulation runs using the Integrated Gaming System (IGS) tool and providing the outcomes of game moves to the participants. In order to accomplish this function, we provided M&S support and direction to the game participants to help in collecting the moves for each unit to input into IGS (the role of inputting the actual moves into IGS was handled by a separate group). We developed a task template for the participants to use to specify both the function and the intent of their moves. We developed a method for analyzing the IGS outputs in order to pull the specific items of interest out of the IGS results database to provide to game participants at both the individual unit and aggregated level. At the end of moves 1 and 2, we repositioned the units within IGS as directed by the appropriate game participants. We developed and maintained a database of forces and equipment for IGS that pertained to the event scenario based on force layout information provided by Cubic. We implemented a map overlay (visual only) to insert in IGS in place of the world map to match the scenario. We also provided training for a group of Cubic personnel to use the IGS tool for supporting the operational workgroups.

Engineering Early Advantage Program - EEAP

Sr. Project Scientist, William Richards supported The ODU Engineering Early Advantage Program for Women (eEAPw). This program consists of 4 weeks of academic and career enhancing activities in a unique engineering setting. This summer, the 15 participants worked at the Virginia Modeling, Analysis and Simulation Center (VMASC) as well as the ODU Department of Modeling, Simulation and Visualization.
Engineering. In addition to the project-based learning at VMASC and the MSVE Department, participants met with faculty administrators and current ODU Engineering students to learn more about life on campus. An important component of the program is the opportunity to see engineering in action by field trips to and visits from area engineering organizations.

Dr. Collins said of the course, "It is truly an honor to engage with the community leaders of tomorrow. Their passion for knowledge is inspiring, if not a little intimidating, and it was joy to expose them to difficult concepts, like the Ellsberg Paradox, to see their eyes light up as they got it. I hope that I have inspired them to think about continuing education here, and, maybe we will see a few of them at ODU in a few years' time."

The course was fast-paced and involved a variety of learning activities from coding a substitution cipher in Visual Basic for Applications (VBA), a bidding game of power station supply, to hands-on exposure of non-transitive dice. The daily sessions were split into an oral lecture, computer workshop and game playing session. Games, Dr. Collins believes, provide a way to teach in didactic manner, especially a subject like Information Theory. The games used included classics like "Clue" and "Mastermind" but also included more modern games like "Love Letter" which received the prestigious Spiel des Jahres 2013 recommended game award. Overall, this course format filled the young minds with thoughts and ideas for their future lives.
and advanced the core mission of both the STEAM Academy and VMASC.

**October 2014**

**Pedestrian and Evacuation Dynamics (PED) Conference - Delft University of Technology, Netherlands.**

The PED conference is one of the most important in the field of pedestrian modeling and simulations. Research Assistant Professor, **Dr. Mike Robinson** and Sr. Project Scientist, **Erika Frydenlund** attended and provided presentations jointly authored with Research Assistant Professor, **Dr. Andrew Collins** and Ph.D. candidate, **Terra Elzie**. Their work was the culmination of VMASC's first year of focused research on pedestrian modeling and concentrated on multiple individual connections in group movements. Presentations were well received and generated continuing conversations and opportunities for cooperative research.

**NAVAIR MSIM Course**

In cooperation with the ODU Modeling, Simulation, Visualization and Engineering Department, Research Assistant Professor, **Dr. Saikou Diallo** provided course instruction to 20 professionals from NAVAIR seeking a certification in Modeling and Simulation. The students learned the basics of M&S and completed a class project in which they developed, built and analyzed a simulation from start to finish.

**November 2014**

**Board of Advisors Annual Meeting**

At this year's Board of Advisors Annual meeting, VMASC Executive Director, **Dr. John Sokolowski** presented current VMASC Advisor Board Chairman, **Mr. Jack McGinn** with an appreciation award for his outstanding support of VMASC and M&S in the Hampton Roads Area.
Following Mr. McGinn's acceptance of the award, he "passed the gavel" to the new VMASC Advisor Board Chairman, Mr. Josh Jackson (SAIC).

Visiting Scholars

In the past year, VMASC hosted two visiting scholars to explore common research interest and funding opportunity. The first researcher, Dr. Katherine Palacio-Salgar from Universidad Del Norte in Colombia spent a month at VMASC working on an NIH proposal that would help AIDS patients in Colombia. She collaborated with Research Assistant Professor, Dr. Jose Padilla and Research Associate Professor, Dr. Andrea Parodi on a successful submission. She also successfully setup an official collaboration and exchange program with the MSVE department.

The second researcher, Dr. Gregory Zacharewicz from the University of Bordeaux spent a week working with Research Assistant Professors, Dr. Saikou Diallo and Dr. Jose Padilla on Cloudes and other interoperability related topics. He and VMASC researchers were able to identify several areas of collaboration and potential funding.

January 2015

VMASC & CITS researchers present at Transportation Research Board

Eight researchers from the Center for Innovative Transportation Solutions joined over 12,000 attendees from around the world at the 2014 annual meeting of the Transportation Research Board in Washington, D.C. The TRB is a division of the United States National Research Council, which serves as an independent adviser to the President, Congress and federal agencies on scientific and technical questions of national importance. The Annual Meeting is the largest transportation conference of its kind and includes thousands of high quality presentations on a
wide variety of transportation topics. VMASC/CITS attendees included: Research Assistant Professor, Dr. Mike Robinson, Associate Professor, Dr. Mecit Cetin, Research Assistant Professor, Dr. Andrew Collins, Sr. Project Scientists, Peter Foytik, Craig Jordan, Erika Frydenlund as well as Ph.D. students Terra Elzie and Afi Anuar with team presentations on topics as diverse as freight truck emissions estimates to connected vehicle modeling and pedestrian evacuations. A highlight of VMASC attendance this year was the establishment of the TRB Standing Committee on Emergency Evacuations and designation of Mike Robinson and Peter Foytik to the highly competitive membership positions.

IMSH for Society for Simulation in Healthcare 2015

Research Associate Professor, Dr. Andrea Parodi attended the 15th Annual International Meeting on Simulation in Healthcare (IMSH 2015) in New Orleans. There were over 2300 attendees from 56 countries. The Society for Simulation in Healthcare (SSH) is the premier professional society for healthcare simulation experts who are educators, researchers, developers, and clinicians. This venue enabled collaboration and peer networking. Among the finalists of the Research Abstract reviews was the 4th place finisher "Performance and Cognitive Load Among
novices Training on Simple vs. Complex Simulation Scenarios, which was Dr. Parodi’s favorite. During Procedural Skills Training by Haji, F. et al., the Program Innovation section first place finish by Friedman, M.I. et al called "Taming Sepsis Education Program: Innovations in Strategy Implementation, Curricular Design, and Simulation" was also of interest to Dr. Parodi.

February 2015

BioPhysics Society Annual Meeting

Research Assistant Professor, Dr. Seth Weinberg attended the annual meeting of the Biophysical Society in Baltimore, Maryland. Dr. Weinberg gave an invited talk on his work on calcium signaling and presented a poster on extracellular matrix assembly, his collaborative project with Christopher Lemmon at Virginia Commonwealth University. Stephen Poelzing, Dr. Weinberg's collaborator at Virginia Tech, also gave an invited talk on their collaborative work on high-frequency electrical stimulation.

March 2015

VMASC Mitigation & Recovery Experts Speak at March Events

Associate Research Professor's Dr. Joshua Behr and Dr. Rafael Diaz presented their latest research at the annual Virginia Emergency Management Symposium. This year’s symposium theme was "Partnerships - Sharing the Load."

The symposium, an annual event jointly sponsored by the Virginia Department of Emergency Management and the Virginia Emergency Management Association, was held at The Hampton Embassy Suites and the Hampton Convention Center on March 18-20, 2015.

Their presentation, "Medically Fragile Populations and the Severe Storm Vulnerabilities in Southeastern VA: Hurricane Irene", covered event mitigation and recovery issues that needs to be considered for citizens who are medically vulnerable both before and after a storm strikes.

The Symposium provided a forum to discuss current trends and topics and share information about the latest tools and technology in emergency management and homeland security. Sessions allowed stakeholders at all levels of government, the
private sector, public health and related professions, to exchange ideas and collaborate to protect lives and property from disaster.

MODSIM World Conference and Expo 2015

MODSIM World 2015 was held March 31 to April 2 at the Virginia Beach Convention Center in Virginia Beach, VA where approximately 400 were in attendance.

The Honorable Terry McAuliffe, Governor of the Commonwealth of Virginia, delivered a rousing opening Keynote address, which was followed by the thought-provoking "Simulation Century" session moderated by Dr. Richard Boyd.

Attendees enjoyed a program of almost sixty papers - which were organized both by track and theme - as well as a wide variety of special programs and events.

One of the special events, the Entrepreneur Competition, sponsored by VMASC's Industry Association, featured six individuals and companies pitching their Modeling & Simulation products in a setting much like "Shark Tank." The winner, Michael Hugos of SCM Globe, received a $1,000 prize for his project "Navigating the Fog of Uncertainty with Supply Chain Simulations".

Additionally, the VMASC Industry Association presented the Modeling, Simulation, Visualization and Engineering (MSVE) scholarships to the following students: Richard Garren, Spencer Smith and Thomas Tracey.
April 2015

VMASC Medical Team Demos at Healthcare Innovation Expo

In partnership with the Society for Simulation in Healthcare (SSH), the Institute of Medicine’s (IOM) Global Forum on Innovation in Health Professional Education (IHPE) invited Research Associate Professor, Dr. Andrea Parodi and Sr. Project Scientist, Hector Garcia to display game-based learning and virtual environment solutions used for training and educating health professionals.
VMASC Big Data Researcher Wins Award for Practical Applications Work

Old Dominion University is a winning institution for the team prize in this year’s Data 4 Development in Senegal Challenge. Research Assistant Professor, Dr. Ross Gore received the award from the Data for Development Senegal (D4D) Innovation Challenge for innovative solutions utilizing big data, winning the Practical Applications Prize.

Modeling and Simulation on Display at VMASC Open House 2015

On Friday, April 17, Old Dominion's Virginia Modeling, Analysis and Simulation Center (VMASC) played host to community members, teachers, local representatives and industry officials at its annual open house.

Visitors were invited to try out flight simulations, games for trauma training as well as virtual reality video games, all developed by VMASC researchers. They also got a feel for the incredible breadth of modeling and simulation research and innovation that is taking place at the university center.

The annual open house is an opportunity for VMASC to showcase its groundbreaking research to an audience of prospective students, clients and local government officials. It offers a hands-on way to educate those in the community about the work done by VMASC researchers and project scientists that directly impacts their daily lives, and it also helps grow the discipline and the industry of M&S in Hampton Roads, which is one of the country's M&S research hubs.
VMASC's New Directions in M&S: Insider Threat Modeling

M&S experts at VMASC recently began joint work with a government agency to create new models for predicting the behaviors that lead to insider threats within an organization. Historically, insider threat has been difficult to model and to predict with any level of accuracy.

"The subject of insider threat is ever confounding as it crisscrosses academic disciplines, vexes analysts, and challenges modelers. Even the term insider threat smacks of conundrum: is the threat solely the individual with access? Is the threat a presented scenario (unanticipated) or a created scenario (manipulated)? Discernibly, it is the intersection of individual and scenario that accurately portrays insider threat. So how does one best represent these elements?" stated VMASC Director John Sokolowski in an upcoming article.

The paradigm shift within this new research is a unique approach, utilizing agent-based models to predict future behavior, examining "the individual as an agent and opportunity as an agent in an environment that represents the individual's access and other agents (individuals and entities) with detection as an eventual output objective."
The goal of the study is to develop a simulation that provides a visualization of how and why a threat develops inside an organization, answering the question: how does a person pre-disposed to being a threat evolve into making the decision to become an active threat? With M&S as a key component in this evaluation, the level of security breaches in the future would be situated for a dramatic decrease.

May 2015

GSA Contract Award Notification

VMASC via Old Dominion University Research Foundation receives its first GSA/FAS Schedule Contract for Schedule 871, Professional Engineering Services.

OLD DOMINION UNIVERSITY RESEARCH FOUNDATION's

GSA CONTRACT NUMBER IS GS-10F-097CA

EFFECTIVE MAY 28, 2015 THROUGH MAY 27, 2020

Virginia Department of Emergency Management Workshop

Research Associate Professor, Dr. Barry Ezell along with Project Scientist's Kaleen Lawsure and David Flanagan supported a Virginia Department of Emergency Management (VDEM) workshop for Public Safety Stakeholders. The purpose of the 1 ½-day conference was to promote the improvement of the homeland security grant program allocation process. Since 2009 there has been a consistent effort to establish, refine, and build upon a risk based formula to allocate funds from these programs. Each year VDEM, under the leadership of the Governor's office, allocates an average of $7 million dollars to enhance homeland security and emergency management across the Commonwealth. It was the goal of this workshop to promote transparency and public safety stakeholder involvement in the decision-making process for the allocation of these critical grant funds across the Commonwealth.

Workshop objectives were to 1) provide stakeholders with a briefing on the strategic roadmap for emergency management in Virginia; 2) provide stakeholders with a briefing on new grant rules and guidance; 3) provide stakeholders a briefing on the past grant process and project proposal scoring methodology; 4) improve the current grant proposal scoring process by determining new project scoring criteria, definitions and weighting from stakeholders; and 5)
improve effectiveness of grant policies by making recommendations.

Thirty-two stakeholders representing multi-disciplinary domains across the Commonwealth's seven regions participated in the workshop. The results of the workshop reflect the values, judgment and experience of the participants and would not have been possible without the energetic and engaged input from the participants.

VMASC role was to serve as the key facilitators. We reviewed prior year’s approaches and facilitated working groups to determine approach for 2015 as well as determine criteria for 2015.

The outcome was a list of decision criteria and the overall approach for 2015 allocation process. VMASC built the data collection systems for the state to submit proposals, the scoring model and the means to collect scores from approximately 100 hundred evaluators across the state.

ODU Researchers' Vulnerability Studies Attract Federal HUD Grant

Research Associate Professor's Dr. Joshua Behr and Dr. Rafael Diaz were awarded a grant from the United States Department of Housing and Urban Development (HUD) to design models that will help identify planning practices that may facilitate the recovery of housing following a disrupting severe storm event.

Association of Unmanned Vehicle Systems

Research Professor, Dr. Yiannis Papelis attended the AUVSI conference under sponsorship from NASA in order to present a paper on how sub-scale aerial vehicles can be used in lieu of full size transport in order to test next generation air-traffic control concepts. In addition, Dr. Papelis met with representatives from three FAA-designated test sites to discuss possible concepts of operation to be used when fielding sub-scale UAS for testing national air-space air traffic management concepts.

June 2015

Frydenlund Selected to Attend Prestigious Santa Fe Workshop

Sr. Project Scientist, Erika Frydenlund has been accepted into the 21st annual Graduate Workshop in Computational Social Science Modeling and Complexity to be held June 21-July 3, 2015, in Santa Fe, New Mexico.
Frydenlund’s proposed project is an extension of the Pedestrian Agent-based Model that she has been performing for CITS (ODU’s Center for Innovative Transportation Solutions), wherein she will investigate how the model changes when one explores refugee flows over longer stretches of time and space. Frydenlund states, "This could have implications for humanitarian policies that identify disabled or physically challenged persons among refugees who would need extra assistance."

NSU and ODU's VMASC Partner on New Center of Excellence in Cyber Security

Norfolk State University (NSU), in collaboration with Old Dominion University and Tennessee State University and in partnership of the Air Force Research Laboratory, has been awarded a Cooperative Agreement by the Department of Defense to establish a new Center of Excellence in Cyber Security. The total funding is $4,984,352 for a five-year period of performance (April 15, 2015 - April 16, 2020).

Teaching Abroad

Research Assistant Professor, Dr. Saikou Diallo spent three weeks as a visiting scholar at the University of Bordeaux. During Dr. Diallo’s stay, he met with several researchers in multiple disciplines and discussed potential collaboration areas. While the focus of the visit was on interoperability, several teaching and research areas including medical ontology, transportation and system science were explored. By the end of his stay, Dr. Diallo collaborated with researches from the University of Bordeaux on a journal paper and a research proposal. Overall the trip was successful in promoting VMASC as a research institution and creating a collaborative environment for future funding.
Research Assistant Professor, **Dr. Seth Weinberg** attended the annual meeting of the Society for Mathematical Biology in Atlanta, Georgia. Dr. Weinberg chaired a mini-symposium session and presented his work on calcium signaling in cardiac cells. Dr. Weinberg also presented a poster on extracellular matrix assembly, his collaborative project with Christopher Lemmon at Virginia Commonwealth University.
VMASC Board of Advisor Message

The VMASC Industry Association enjoys the partnership with ODU's VMASC to further the application of research and development and increase awareness of how modeling, simulation, analysis can be applied to some of our nation's most difficult challenges. We continued initiatives like scholarships, education support, sponsorships, and entrepreneurial contests, while expanding initiatives to enhance collaborative R&D and more visibly expand our reach beyond government applications of modeling, simulation, and analysis.

The VMASC Industry Association continued our baseline support to ODU's modeling, simulation, and visualization engineering department, which is paving the way in creating a highly talented workforce. Our scholarships were able to support two rising seniors finish their undergraduate education in modeling and simulation. Our continued support to the capstone conference provided a venue for students to showcase the work they've done throughout the year. Our support to ODU's MSVE department is a very important aspect of our partnership.

We've also expanded our efforts to create R&D partnerships between VMASC industry association companies and ODU. With ODU's renewed interest in expanding funded R&D, these kinds of collaborative R&D partnerships will generate new intellectual property and economic development. These R&D efforts also hold promise for continued diversification of local modeling, simulation, and analysis efforts to a broader set of markets. VMASC is a leader in modeling and simulation and we're fortunate to have such a national asset in this region.

Finally, we've added to the VMASC industry association membership which will allow us to focus on applications to new markets. This will give VMASC and ODU industry perspective on where big modeling, simulation, and analysis challenges exist and give the industry association valuable insights into new markets for application of R&D in which ODU and VMASC is engaged.

There's more work to do, but I'm proud of the accomplishments of the industry association and leadership of the board of advisors to further the state of research and development in modeling, simulation, and analysis. I look forward to working with ODU, VMASC Industry Association, and local leaders to expand the role of modeling and simulation to address complex challenges in the world.

Josh Jackson
Vice President of Training and Simulation, SAIC
Chairman of the VMASC Board of Advisors
VMASC Awards
July 2014 – June 2015


Mobile App to Measure Tool Wear - CCAM. 8 June 2015 - 31 July 2015. PI: Krzysztof Rechowicz, Ph.D.


Center of Excellence in Cyber Security. 15 April 2015 - 14 April 2020. PI: Jose Padilla, Ph.D., Co-PIs: Saikou Diallo, Ph.D., Ross Gore, Ph.D., Sr. Project Scientist: Anthony Barraco.


Freight Train Model. 1 April 2015 - 30 August 2016. PI: Mike Robinson, Ph.D., Sr. Project Scientists: Craig Jordon and Erika Frydenlund.

HUD Housing Demand Capacity. 17 March 2015 - 16 March 2017. PI: Josh Behr, Ph.D., Co-PIs: Rafael Diaz, Ph.D., Bridget Giles, Ph.D., and Project Scientist: Kaleen Lawsure.


Microscopic Transportation Model - City of Portsmouth. 01 July 2014 - 31 March 2015. PI: Mike Robinson, Ph.D., Sr. Project Scientists: Peter Foytik, Craig Jordan and Erika Frydenlund.

Adaption Response to Recurrent Flooding - City Portsmouth. 01 July 2014 - 31 August 2015. PI: Josh Behr, Ph.D., Co-PIs: Rafael Diaz, Ph.D., Bridget Giles, Ph.D.

VMASC Scholarly Work

Journal Articles


Book Chapters


Conference Proceedings and Presentations

Weinberg SH and Smith GD. "Calcium buffers do not suppress and may enhance calcium fluctuations in the cardiac dyadic subspace." Society for Mathematical Biology Annual Meeting, Atlanta, Georgia. June 30-July 3, 2015


**Weinberg SH**. "Fluctuations in calcium concentration alter the temporal dynamics of calcium-dependent signaling cascades." Biophysical Society Annual Meeting. Baltimore, Maryland, February 7-11, 2015


**Weinberg SH** and Smith GD. "Calcium buffers do not suppress (but may enhance) intrinsic free calcium concentration fluctuations in calcium microdomains." Society for Neuroscience Annual Meeting, Washington, DC, November 15-19, 2014


McLeod George, **Behr Joshua, Diaz R.** GIS for Storm Flood Population Vulnerability Analysis. CoastGIS 2015 conference. 23 April, 2015 South Africa.

Ernest David, **Behr Joshua, Diaz R.** Social Capital or Social Vulnerability? Assessing
Competing Determinants of Community Resilience and Recovery from Natural Disasters. Annual meeting of the Midwest Political Science Association (MPSA), Chicago, IL, April 17, 2015.


Advanced Manufacturing focuses on integration of technology based processes and systems to deliver products characterized by the highest level of quality and in compliance with industry specific standards. Advanced Manufacturing is very often associated with terms like innovative, made from advanced materials and components, and produced on technology driven equipment and processes. Any company that utilizes Advanced Manufacturing principles commits to strive to be the leader in its class. This is expressed by employing a highly skilled workforce operating in lean and continuous improvement cultures, and with constant awareness of customer expectations.

Achieving the aforementioned goals is not possible without M&S. Over a year ago, Old Dominion University joined the Commonwealth Center for Advanced Manufacturing (CCAM) - an applied research center that bridges the gap between fundamental research typically performed at universities and product development routinely performed by companies. Virginia Modeling, Analysis and Simulation Center delegated its faculty, Dr. Krzysztof Rechowicz, to serve as a full-time on-site representative and active researcher. With his dual role, he has a unique opportunity to collaborate with CCAM member companies, like Rolls-Royce, Newport News Shipbuilding, Sandvik, to identify challenges in the M&S domain important for their operations and work on providing research-based solutions.

It is evident that a lot of M&S challenges in the advanced manufacturing domain are associated with product and process digital data. For instance, in many manufacturing processes, digital data that exists for a part or process (CAD models, process instructions, sensory data, quality data, etc.) is either not accessible while performing the process, or must be interpreted into another form (such as print drawings) for use by the workforce. This is particularly applicable to those processes that are performed, at least in part, manually. These include part or unit assembly processes, quality inspection, surface preparation & coating application to complex assemblies, etc. Providing real-time digital data for feedback and/or control that correlates to the worker's physical environment and current process would be extremely beneficial to the worker and the process outcome. Therefore, VMASC’s team lead by Dr. Rechowicz is investigating the use of a flexible augmented reality (AR) system for integrating digital design and process information with the worker's physical environment for feedback and control of manufacturing processes. The choice of AR for this task is justified by rapid growth in wearable technology and foreseen AR market of $120 billion by the year 2020.

Available AR technologies (such as glasses, tablets, smartphones, etc.) have been evaluated against manufacturing process and environment needs (including portability, IT communication & security, visibility and interferences, among others). A framework for correlating product design data, location configuration data, process sensory data, and worker location is being developed to augment the physical work environment through down-selected AR form factors. This project is being executed at CCAM with support of Newport News Shipbuilding, Sandvik, Alcoa, and
Mechdyne, which also provide real-world use cases.

Besides answering how to deliver process and product information, M&S focuses on data itself. Manufacturing processes generate terabytes of data every day and extreme changes in variability are not unusual, sometimes even after implementing lean and Six Sigma programs. Taking into account the number and complexity of manufacturing operations that influence yield, a more granular approach to identifying and fixing process flaws is required. Big data analytics now allows to take a deeper look into historical process data to identify patterns and relationships among discrete process steps and inputs. With that being said, the type of analytics will depend on the role of a stakeholder. A machine operator would benefit from a warning that tool failure is imminent or has just occurred. Currently, it is not always possible because individual sensory data is not sufficient without applying M&S techniques. Early failure detection can reduce scrap and improve productivity. A plant manager is in turn interested in a macroscopic view of the operation but high level performance indicators rely on detailed information from the shop-floor which dictates the bottom-up rather than common top-down approach to developing analytics.

Looking at the big picture, M&S plays a critical role in intelligent/smart manufacturing revolution which aims at high flexibility, agility, movability, and further reducing negative impact on the environment. These objectives can be successfully achieved by establishing a close relationship between the manufacturing industry, academia, and state and federal agencies. VMASC is an active stakeholder in the smart manufacturing initiative which is proven by successfully implemented M&S tools in CCAM members' organizations.

THE ART OF ANALYSIS IN SIMULATION

A simulation's practical use determines its eventual worth. The Department of Defense (DoD) identified three uses for Modeling and Simulation (M&S): Training, Experimentation and Analysis. We see training occurring in serious-game simulations, simulations replacing prototypes for experimentations, and analysis simulations supporting decision-makers. Simulations provide a tool, through its output data, for an analyst to explore and theorize about the world, which might be impractical or unethical to achieve otherwise. These explorations and theories are then reported to decision-makers to support them in their task.

A layperson might assume that once the data has been collected the expected results of an investigation will be immediately found. However, even in this data-rich world, this is not the case as data has to be interpreted first or, as Albeit Einstein put it, "information is not knowledge." This interpretation is one of the main roles of an analyst and the first step of this interpretation is to determine whether the correct data has been collected. This in itself can be a non-trivial task, for example,
VMASC is currently running a project with the National Institute of Standards (NIST) into the developing a process of selecting key Performance Indicators (KPI) portfolios. KPIs are measures that allow a company to determine how well it is doing compared to its goals, for example, the goal might be to reduce workplace accidents and the KPI might be the monthly number of accidents. Most companies have multiple goals/objectives and thus multiple, potentially overlapping, KPIs might be employed thus determining an efficient KPI portfolio is important to the health of the company.

Data might not exist to be investigated and interpretation. This might occur due to the system under consideration not existing yet. For example, VMASC is working with the University Transportation Center @ Maryland on possible roadway tolling mechanisms in a Vehicle-to-Vehicle (V2V) / Vehicle-to-Infrastructure (V2I) communication environment. As this type of communication technology propagates throughout society, it opens new possibilities for tolling, e.g., auction-based tolling. Since this technology does not exist yet, our analysts rely on sophisticated game theory approaches to investigate which auction-based tolling mechanisms are most effective.

Analysis is not only used on a simulation’s outputs but also on its inputs. For example, VMASC has much expertise in evacuation modeling (http://rtepm.vmasc.odu.edu/ and the Southeastern Parkway Assessment) and one particular concern, in these projects, is the impact of traffic incidents on the overall evacuation time. Unsurprisingly, data does not exist for traffic incidents rates in an evacuation thus the project time used statistical analytical approaches to determined incident rates and impact.

Dr. Andrew Collins, our resident analyst, is involved in the projects described above and many more including understanding group behavior in crowds, visual rhetoric, scheduling heuristics for medical schools, and understanding the impact of decentralization of control on our electrical distribution system. Dr. Collins believes that "in an increasingly complex world, more analysis will be needed to help us make sense of it all." As M&S expands in its usage, so will the need to analyze its results.

BIG DATA

Humans are producing more and more data. By using gathering this data and exploring it innovatively we can generate forecasts and insight into complex problems that previously had been to cost and time intensive to explore.

VMASC researcher, Dr. Ross Gore, received an award from the Data for Development Senegal (D4D) sponsored by The Bill & Melinda Gates Foundation for their approach to facilitating health care-decision marking using mobile cell phone data from more than 300,000 Senegal citizens. Dr. Gore's team identified: (1) the population density across the 14 regions of the country and (2) risk zones where citizens who suffered from either strokes or heart attacks (Myocardial infarctions) would be
unable to reach a hospital to receive treatment in 90 minutes or less. In combination these two results informed decision makers about where to establish future Senegal hospitals to minimize stroke and heart attack risk zones. The result will reduce the cost and accelerate the delivery of health-care infrastructure across Senegal.

Dr. Gore is finding that other data sources like Twitter also provide insight into human behavior. Typically, full-scale surveys from companies like Gallup are needed to estimate population-level measures of urban areas. However, using geotagged tweets in Dr. Gore has been able to come up with measures of obesity, exercise and overall well-being for 189 different cities in the United States. This work reflects a large step toward the development of a cost-effective real-time measures of population characteristics.

Additional modeling and simulation opportunities exist for big data as well. According to Dr. Gore, "M&S is unique in that we constantly adapt techniques to remove assumptions, but also we have to investigate what M&S problems with simulation and visualization can be solved using new big data tools. For instance, mining publicly available data allows us to identify realistic inputs, add more validity to results, and use more agent-base models configured using legitimate observable characteristics."

According to Dr. Gore, the future of big data is all about integrating these new sources of data to create better intelligence and analytics. The example he uses to illustrate this is retail stores making decisions based only ones inventory sold the week before and after a snow storm. In the future the store manager will be able to access a predictive model that forecasts expected inventory sold under different weather conditions.

"Integrating diverse public data sources on the Web with the emergence of the Internet of Things and the yet-to-emerge new-data-generating technology into one coherent data model to enable such models is going to be a challenge. However, the problem is mainly engineering, not innovation. We can create a solution by combining automated machine learning with the crowdsourcing of domain experts, we just need to work on putting it together."

**BIOMEDICAL ENGINEERING**

VMASC has expanded its modeling and simulation efforts into new and innovative projects in biomedical engineering and computational physiology. Physiological signaling is highly complex and occurs over an immense range of scales in space and time, from interactions between individual proteins in microseconds up to whole organ systems in hours and days. Complicating our understanding of biology even more, at the molecular level, physiological processes are inherently random. M&S provides a powerful tool to understand how all of these physiological systems interact, are perturbed during disease, and how they may respond to potential therapies.
Using M&S approaches that can reproduce these complicated interactions, we can study many disorders. VMASC Research Assistant Professor Seth Weinberg has recently begun efforts to develop a computational model of how cells assemble an important protein known as fibronectin. "Fibronectin is a protein that cells assemble during a disorder known as fibrosis, and fibrosis is responsible for organ failure in heart, liver, lung, and kidney disease and also plays a prominent role in malignant tumor growth. If we can build a model that understands how this protein is assembled in fibrotic tissue, we can make predictions about possible therapies that might reduce the harmful effects of fibrosis," states Dr. Weinberg.

Modeling protein assembly is a computationally intensive challenge. "We are modeling biochemical reactions that can occur every few millisecond, while protein assembly can take many hours to days. We can use parallel processing to break our simulations into many smaller pieces and run them at the same time. Also, a critical component of any computational physiology project is collaboration with good experimentalist who can determine model parameters and test model predictions. We have been collaborating with Dr. Christopher Lemmon, an assistant professor in the Biomedical Engineering Department at Virginia Commonwealth University (VCU), and Devin Mair, an undergraduate student at VCU in Dr. Lemmon's lab."

Drs. Weinberg and Lemmon presented preliminary work at the annual meetings of the Biophysical Society in February 2015 and the Society for Mathematical Biology in July 2015 and are scheduled to present at the upcoming Biomedical Engineering Society annual meeting in October 2015. The collaborative team was recently awarded a 5-year R01 National Institutes of Health (NIH) grant through the National Institute of General Medical Science (NIGMS). As these M&S projects progress, VMASC continues its growth and efforts in computational physiology.

CLOUD-BASED SIMULATION ENVIRONMENT

Despite their proven advantages in science and engineering and their broad application in daily activities, such as financial planning, models and simulations have not been widely utilized in education, particularly in the K-12 environment. One of the main reasons is that simulations are reserved for expert use and have a steep learning curve for novices. Modeling and Simulation (M&S) provides untapped educational advantages such as exposing students to STEM concepts and skills in simulation design and simulation development among others. Yet, concerted efforts for creating awareness and educating students, parents and teachers on simulation modeling, such as code.org and scratchjr.org for computer programming, are difficult to find.

At VMASC, we are trying to bridge that gap on two fronts: developing simulation environments that are easy to use and by conducting STEM outreach.
1. **Cloud-based Simulation Environment**

If by using a browser we watch movies via Netflix or write documents via Microsoft 365, why don't we create simulations in the same manner? Cloud-computing is one of the technologies driving the 21st century. Yet, we run simulations relying on computers instead of mobile devices. Not only are we relying on old technology but by making it more complicated to the novice we are limiting access to a wide range of students and small businesses. Simulations environments don't need to be complicated. They can be easy to use and accessible the way non-experts want to access information today: anywhere and at any time. At VMASC we developed CLOUDES to make simulations accessible to the person that does not need a complicated tool. CLOUDES is one of the few web-based simulation environments where people can build and play with simulations and likely the first to be cloud-deployed. CLOUDES provides both the non-expert and expert the capability of creating discrete-event simulations anywhere, anytime. The tool has been successfully introduced to high school students and to undergraduate and graduate students at ODU.

2. **Simulation for STEM Education:**

VMASC hosted a group of nine students from Churchland High School in Portsmouth, VA who participated in a small pilot study. The goal of the study was two-fold: familiarize students with modeling and simulation through CLOUDS and explore what they complicated topics to learn are and how we can simplify them. The students are part of the STEM group at Churchland High School led by Mrs. Danielle Morgan. The group conducts summers activities in the area of robotics during the summer. We expect to conduct more pilot studies in order to better understand how people create simulations and to generate awareness of the benefits M&S provide.

**Cyber Simulation Environment**

Cyber Security is at the forefront of our ever-growing digital presence. Recently, a month does not go by when we do not hear about data breaches or systems being compromised due to hacking activities by individuals, groups or (allegedly) nations. Deterring, detecting or addressing illegal cyber-activities is a major challenge as no system is breach proof. The very nature of the internet is that of an open and always emergent network. As more and more of these events occurred more people need to be trained and more strategies need to be developed. This is where M&S play a role: provide the ability to generate potential scenarios that combine different systems including networks and people.

At VMASC we are currently exploring the roles that simulations can play in cyber security ranging from simulating humans within the cyber-domain to simulating cyber-infrastructure. One of the expected outcomes is to develop a cyber-simulation environment that facilitates not only research in cyber but also training under a great variety of scenarios.

This effort is funded by a grant awarded to a team of researchers from Norfolk State University, Tennessee State University and
Old Dominion University. The primary mission of the project is to conduct multidisciplinary, collaborative research that can increase knowledge in the area of cybersecurity and have the potential to lead to practical applications to counter cyber-threats to the country's military capabilities, and to provide opportunities for faculty and student participation leading to increased capacity in research, education and professional development.

Social Media and Simulations

Social media for learning about human behavior and predicting trends has been used largely by marketing organizations. More recently, social media data has been used by the scientific community to make predictions in areas ranging from obesity to the spread of diseases. The wide availability of this data and its proven added scientific value makes it worth exploring how it can improve the empirical grounding of simulations.

Currently at VMASC, we are exploring how this type of data can be used for simulation initialization and validation of agent-based models of human behavior. Social media can be mined using big data techniques for data in areas like human mobility and connectivity.

Computational social sciences attempt to model how humans interact with each other and the environment. Researchers can use these models to gain understanding of a wide variety of complex systems that underlie social phenomena. How does concern for others among family members affect building evacuation times? How do social movements affect the spread of HIV/AIDS or the outcome of political elections? Computational models of social systems help to tease out important theories that might not be noticed by observation of the real world.

Using modeling and simulation techniques applied to the social sciences, we can uncover previously unseen relationships and interactions, as well as test theories and policies in ways that would be impractical or impossible to perform on real people. For instance, in models we can look at what would happen if concern for others did not exist among an evacuating population—no parents would slow down to help their children leave the building. While researchers cannot ethically recreate an entirely selfish evacuation experimental environment, these social models help policymakers understand the importance of including family dynamics when planning for effective evacuation routes, rather than assuming that every person would exhibit the same exiting behavior.

Specializing in agent-based modeling techniques within the field of computational social science, VMASC Senior Project Scientist, Erika Frydenlund, had the opportunity to explore these issues when she was selected for the Santa Fe Institute 2015 Graduate Workshop in Computational Social Sciences in Santa Fe, New Mexico. The Santa Fe Institute is a globally renowned research foundation focused on the exploration of complex systems in all
areas of science. The highly competitive selection process based on a project proposal allowed for a diverse collection of participants representing top-ranking research institutions throughout the world.

As one of just ten participants chosen from a global applicant pool of graduate students from a variety of social science fields, Frydenlund spent two weeks at the workshop constructing an agent-based model of overland refugee migration. Two premier researchers in complex adaptive systems, John H. Miller of Carnegie Mellon University and Scott E. Page of the University of Michigan, led the two-week workshop. Participants worked directly with the two program coordinators, attended lectures by a number of the Institute's faculty and visiting scholars, and also worked on group and individual modeling and simulation projects. The workshop culminated in a presentation and discussion at the Institute of the individual projects by each participant. Frydenlund's model of land-based refugee migration and family dynamics was well received, and she was encouraged by her mentors and peers to continue developing that line of research.

Computational social science is a fruitful area to promote VMASC's interdisciplinary groundings. An agent-based modeling working group led by VMASC researcher Andrew Collins meets regularly to bring together researchers from across the university to discuss multidisciplinary approaches to modeling complex social systems. VMASC researchers also engage in the larger dialog about computational social science at academic conferences. Two VMASC researchers, Collins and Frydenlund, presented models of social systems at SwarmFest in Columbia, South Carolina in July. VMASC continues to grow its areas of research and application of modeling and simulation tools to social phenomena.

MEDICAL AND HEALTHCARE

Medicine and Healthcare delivery in the U.S. has been evolving, in part as a means to keep up with the tremendous growth of new knowledge in all the sciences and technologies. One preeminent approach to handling the vast array of new information and the digital data generated has been to look to the discipline of engineering, systems science, and ultimately to modeling and simulation for better approaches and potentially practices that can benefit, in this case, medicine and healthcare. In fact the Institute of Medicine and the Academy of Engineering have engaged in roundtable conferences over the last few years to identify and develop best practices from the engineering community along with clinicians. One such area of growth seen within the healthcare sector has been the rise in the use of both computational modeling and simulation and any number of other types of simulation promoting research and experimentation that is virtual, live, in situ, in silico or from the computer, to the in vivo or lab based types of simulation. So in the medical area, simulation takes on many different meanings and uses to ultimately assist in improving healthcare practices and outcomes. The following represents possible
areas that modeling and simulation and the use of simulators benefits healthcare in local and global ways, they are: the development and use of decision assist tools or data driven clinical guide lines that also help the clinician plan or "predict" the patients potential recovery course and trajectory; curriculum design and testing, as well as learner performance evaluation, based on data supported evidence based practices; sensitivity or efficacy testing of programs, processes, drugs and labs as well as prototype testing for planning, care delivery or a proof of concept. The VMASC Medical and Healthcare Lab engages with colleagues and collaborative partners from civilian industry, academia and the Department of Defense medical departments, enabling a wide diversity of specialization as you will see in the follow overview of our work.

What We Do

"It isn't that they can't see the solution. It is that they can't see the problem."

- G. K. Chesterton

We introduce to many unique approaches to problem identification, clinical education, and process improvement using multiple types of modeling, simulations or through the use of simulators as appropriate. For our work, simulation provides what Tuncer Oren (2011, p. 144-145) states is an "experience under controlled conditions for gaining /enhancing competence in one of the three types of skills: (1) motor skills (virtual simulation), (2) Decision making and Experiments Physical experiment (real experiment) decision and/or communication skills (constructive simulation; serious games), and (3) operational skills (live simulation). Simulated experiences provide fast, risk-free, and systematic training possibilities in numerous civilian and military application areas." The VMASC Medical and Healthcare Lab engages in all the above areas. An example of a blended use of both computational M&S and the use of models, or representations of a reality and a live simulation involved the tracking of an infectious disease aboard a particular class of Navy ships. Although occurring a number of years ago, this prior history enabled the VMASC team to collaborate with an M&S local firm to produce Navy doctrine on this topic.

This year, Subject Matter Experts (SME) for a multi-million dollar Joint Services Research project awarded to the Army sought out VMASC Medical and Healthcare Lab as collaborators on a study that focuses on the Efficacy of the Role 2 and 3 Operational Capabilities. Role 2 is considered non-definitive, staged care, saving life, limb, and vision. Role 3 is a definitive level of care. This study will look at how the environment, resources, and policy impacted patient outcomes in these role areas of care and what clinical capabilities, performance and outcome metrics are needed. Selected in part due to her prior experience as the Principal Investigator for the development, construction, and deployment of a maritime Role 2 Shipboard Surgical System (SSS), Dr. Andrea (Andi) Parodi, lab lead and Research Associate Professor, was also a member of the original design team for the Role 2 Forward Resuscitative Surgical System (FRSS) for the Marine Corps. Consequently, the team will be looking at Role 2 and 3 surgical capabilities for medical and nursing clinicians. Since Dr. Parodi also supported the technical report generation and analysis for determining the medical mission capability of the high-speed vessel 1 and 2 for the Navy, she is also very familiar with conducting operational analysis, design and process trouble-
shooting for care related delivery issues, thus supporting our newest project area needs along with the rest of this team.

The VMASC medical and healthcare team is also well versed in using simulation for education and training of healthcare professions, as well as proposing the "what if type scenario" related to care or management interventions. In fact, with the support of the VMASC experts, like Sr. Project Scientist Hector M. Garcia, the team has been able to incorporate the use of computer virtual environments, gaming, and data visualization, into proposals and projects. Dr. Bridget Giles, Research Assistant Professor, is currently working on projects in support of Dental Hygiene and military chaplains' need for computer and app based support of information related to the prevention of warrior suicide. We also developed a suite of trauma games based, not on a civilian model of care, but rather on the highly successful model of care guided by the Clinical Practice Guidelines that are derived from the Joint Theatre Trauma Registry Data by the Institute for Surgical Research at Fort Sam Houston, Texas. Additionally, a trauma-training curriculum was developed for military Nurse Corps officers.

Another major area of expertise for the Medical and Healthcare Lab at VMASC is in the area of patient safety. Unfortunately, little progress has been made at reducing the numbers of preventable deaths from medical errors. A U.S. Senate subcommittee on aging in 2014 reported that about 440,000 people die each year from preventable medical error. This is the third leading cause of death in the United States, trailing only heart disease and cancer. Dr. Parodi and her team were awarded by the Joint Program Office1 via TATRC an award that has funded the development and testing of an avatar guided, computer simulation program entitled, "A Theoretically Driven Investigation of the Efficacy of an Immersive Interactive Avatar Rich Virtual Environment in Teamwork Skills Training." This multi-site project incorporates an avatar guide through the concepts and techniques used in TeamSTEPPS. This is a program developed by the DOD and Agency for Healthcare Research and Quality to promote improved team communication and cooperation, developing groups of highly effective expert teams. We are currently in the testing phase of this program.

Inter-professional Practice-based Education and Training

Since this lab's inception there has been community out-reach to support efforts for patient safety through simulation based education and training. To that end, support and collaborative partnerships have enabled the all EVMS faculty coordinators in the School of Health Sciences prior to the beginning of a new course on Inter-professional Medical Education were trained on the basics of TeamSTEPPS. The initial introductory course was conducted during the fall semester 2014 and is now, 2015, evolving and offered annually. During that course, all of the students were also trained in knowledge components of TeamSTEPPS. The goal of the program is to forge a knowledge and understanding of the many disciplines involved in the success of a patient's care in today's healthcare process. Through this knowledge will come better utilization of services, a more holistic patient centered assessment of need and intervention that also brings the patient and family into the circle of communication. This can optimize care while reducing waste, error, and unnecessary time lost from work. The course and the road to true inter-
professional education continues with our VMASC support.

**VMASC and EVMS Partnership with LIVES LAB**

In 2012, Dr. Parodi was awarded $50,000 as PI for the LIVES and SIM Lab Investigation, Validation and Verification of Emerging Simulators from the State of Virginia via VMASC and EVMS. Work was completed December, 2012. Lives lab was a process that was developed, tested and validated by a multi-disciplinary group of subject matter experts from VMASC, Old Dominion University, and EVMS in relation to identifying the value added and efficacy of simulations and simulators. As anyone associated with the management of education, training or simulation centers will tell you, the cost, repair, and sustainment of devices, equipment, supplies and software is extraordinary. This process provides a focus on the core work needed, best clinical practices, human factors integration of content, purpose, person, and product. To that end, LIVES lab provides a means to identify value-added to a submission on inter-professional practice approaches, patient access, use, and cost.

**Wrapping up the Year 2015**

In May of this year, we were invited to present a suite of Clinical Practice Guideline Based Trauma Games for Military Nurses and the Course for Operationally Relevant Avatar Guided TeamSTEPPS Instruction to a Game Arcade sponsored by the Society for Simulation in Healthcare and the Institute of Medicine at the IOM Headquarters in Washington DC. The work was very well received. Prior to this invitation, staff from the local Naval Medical Center asked to see a prototype of our trauma games, still in development. They would ask if they could "play" and ultimately requested a copy of the prototype that they could take with them to sea. Promising they would give us feedback when they returned, we realized that these prototype games would be able to support staff members while deployed, and this was very gratifying.

We were also fortunate to be receive funding from the Army in support of a major study of Role 2 and Role 3 capabilities and efficacy. We will identify trauma capabilities for military physicians and nurses based on the Clinical Practice Guidelines and develop corresponding validated knowledge tests. This will be a two year project.

Dr. Parodi also submitted a chapter related to the impact on the education of healthcare professionals and the expansion of digital patient research for a book called The Digital Patient. See: "The Digital Patient: Advancing Healthcare, Research, and Education" for a book currently in press. Edited by C. Donald Combs, John A. Sokolowski, Catherine M. Banks]). Copyright © 2015 Wiley Inc. and continued to teach the core content of TeamSTEPPS® for Clinical Safety and Team Efficiency" each year, for the School of Health Sciences, Eastern Virginia Medical School (EVMS), Norfolk, VA. (2012-2016). In October, 2015, Dr. Parodi was able to team teach with Mr. Clint Crews, Head of the Surgical Assistance Program at EVMS during the Interprofessional Education Course.
SIMULATION IN SUPPORT OF POLICY AND HEALTHCARE

Innovative Action-Oriented Research Process (ARP)

Provides Actionable Information to Planning and Policy Officials

Among the many VMASC strengths is the ability to harness, combine, and analyze data from several ecologies or systems in an effort to generate knowledge that may be used in support of local and state decision making. Planning and public policy decisions must take into consideration the impact these actions may have upon the citizenry as a whole and specific population groups in particular.

VMASC understands that our local and state partners need actionable information. The unique & innovative process by which VMASC generates this knowledge has been termed the "Action-Oriented Research Process," or ARP for short. The ARP applies a science-based approach in support of public planning and policy issues.

The four-phase Action-Oriented Research Process is custom tailored to intelligently integrate several data streams so stakeholders can better understand the complex interactions among natural, built, and behavioral systems. This enhanced understanding translates into meaningful policy influence that may decrease risk and enhance the overall health and welfare of our citizenry.

The Action-Oriented Research Process consists of four distinct phases. In the first phase, Natural System Data are engaged to model the natural environment, which, in turn, is intersected with Human System Data, both behavioral and experiential. Indeed, VMASC has expertise in surveys, interviewing, and data gathering to complement existing behavioral datasets the stakeholders may have. In the second phase, analytics are performed to generate actionable information on specific research questions, such as the economic impact of planning or policy decision. In the third phase, this actionable information is disseminated to planning and policy stakeholders. In the fourth phase, VMASC supports the documentation of the impact these planning and policy interventions may have upon system behavior.

Phase 1 -- Data & Outreach: Acquisition and Integration

Phase 2 -- Analytics: Generation of Actionable information

Phase 3 -- Engagement & Dissemination: Planning and Policy Influence

Phase 4 -- Impacts: Measuring System Change

For example, VMASC can leverage Natural Systems data sources, such as those that characterize tidal movements and surge conditions associated with severe weather events, and link these with unique Human System behavioral data. Together, these data streams can be analyzed to generate actionable knowledge and insights to help inform local and regional decisions, thus
resulting in planning and policy that optimally decreases population risk while at the same time enhancing resilience. VMASC can then quantify the measurable impact these planning and policy interventions may have on risk and resilience of communities as a whole and vulnerable populations in particular.

**TERRORISM RISK ASSESSMENT SIMULATION**

Supporting decisions through terrorism alternatives analysis in real time

Adaptive adversaries are a fundamental component of terrorism risk modeling. Unlike natural and engineering hazards, adversaries adapt their behavior to the actions of the defender. They adapt to observed, perceived, and imputed likely future actions by those defending the system they are attempting to influence. Risk assessment models need to consider these potential adaptive behaviors to be able to provide accurate estimates of future risk from adversaries and appropriately support risk management decision making. Homeland security risk analysts require the ability to explore the consequences of different scenarios of interest under changing conditions and the impacts of mitigation strategies to support decisions with limited resources.

VMASC is investigating new ways to simulate terrorism risk. VMASC developed the Terrorism Risk Assessment Simulation (TRASIM), a prototype that directly addresses these requirements through a desktop/laptop simulation environment. TRASIM visualizes scenarios and allows analysts to fully or partially specify scenarios of interest and observe how event outcomes change when different mitigation strategies are applied in minutes. TRASIM is designed to allow analysts to inspect and change the probability distribution of events within each node in the tree. These capabilities will allow analysts to assess adaptive adversaries' responses and behavior choice models using TRASIM, and help support decisions through helping to understand the risk-reduction impacts of various mitigation strategies.

It is platform independent and can be ported to mobile platforms or made accessible through web-browsers. Since the current prototype can perform 1,000 trials in less than two minutes, and runs on standard Windows and Macintosh desktops and laptops, it can easily be installed on classified Government systems as well. A screenshot of the graphical user interface of TRASIM visualizing the Bioterrorism Risk Assessment is shown below.
The graphical output of the TRASIM is configurable. Users can choose to display the likelihood of a scenario producing a certain level of consequences as either a boxplot or histogram. An example output of a scenario is shown in the figure below. The expected risk is computed for the overall scenario and different partitions of scenario consequences. This capability enables analysts and decision-makers to understand and highlight the risk of unlikely events that despite extreme consequences do not influence the overall (i.e. mean) risk assessment.

In addition to exploring specific scenarios, TRASIM also offers analysts the ability to search through all parts of scenarios to identify nodes that, if their values were modulated, would have the most risk-reducing impact.

TRANSPORTATION

Will a new freeway improve traffic conditions during peak commuting periods? Or will it make it easier for more vehicles to further congest nearby roads?

Will the large numbers of anticipated fans leaving a proposed athletic stadium improve business opportunities in the surrounding areas? Or will event-related traffic congestion and reduced parking availability cause local businesses to suffer?

How early must residents begin to leave a coastal area for everyone to reach safety before a hurricane arrives? How will traffic accidents and incidents affect travel times?

Just a few years ago, answers to these questions were based on national or international approximations and the experience and expertise of local authorities. Then, the intense computing resources required to model transportation at the individual vehicle and road lane level limited the scale and explanatory power of microscopic transportation simulations. Now, however, it is possible to accurately model entire cities in great detail.

Researchers from VMASC's Center of Innovative Transportation Solutions, including Mike Robinson (recently named a member of the Emergency Evacuation Committee of the Transportation Research Board), Andy Collins, Peter Foytik, Craig Jordan, and Erika Frydenlund, are nearing
completion of microscopic transportation simulations of the Virginia cities of Virginia Beach and Portsmouth. Each city's model includes all highways and primary and secondary arterials and even some selected neighborhoods. Traffic signal timings, stop sign placement, and numbers of vehicles traversing the roadways correspond to historical data provided by each of the cities. The models reflect average roadway usage and congestion during peak commuting periods.

The Virginia Beach Model, which includes portions of eastern Chesapeake as well as the I-64 and US-58 corridors to Suffolk, will be used to assess the benefits of the proposed Southeastern Parkway and Greenbelt limited access road. The model will provide a means to compare this potential roadway with alternative improvements to the existing network. Testing will involve simulating evening peak period conditions as well as two hurricane evacuation scenarios. The City of Portsmouth expects to use its new model to mitigate problems with recurrent flooding resulting from sea level rise and better plan for increasing freight rail schedules impacting roadway traffic. Both models include the ability to test impacts of accidents and incidents where location, severity, and frequency are based on past reported events.

The transportation team has also pursued advances in pedestrian simulations using agent-based modeling. A core team, including Collins, Frydenlund, and Robinson, has developed models for testing the influence of social groups on crowd behaviors. Ph.D. candidate Terra Elzie is building on this foundation to model group influences on pedestrian behavior during large scale evacuations. Drs. Frydenlund and Robinson presented early results to a very receptive audience at the 2014 Conference on Pedestrian and Evacuation Dynamics (PED) held at the Delft University of Technology in the Netherlands.

The work in modeling and simulation applied to citywide microscopic-level transportation and pedestrian egress keeps VMASC at the forefront of advanced transportation research.
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