REPORT OF THE ODU M&S STEERING COMMITTEE ON
THE M&S GRADUATE ASSISTANTSHIP PROGRAM
Revised July 2018

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John Baaki, Darden College of Education
Dean Chatfield, Strome College of Business
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Steven Morrison, Health Sciences
Jesse Richman, Arts & Letters
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Summary
Old Dominion University is recognized as a world leader in Modeling & Simulation (M&S). This report summarizes the progress of students enrolled in the M&S Graduate Assistantship and Certificate programs over the last seven years and provides an update to one prepared in November, 2014. During this period, 156 students have received a doctoral or a master’s degree and 128 M&S certificates have been issued. At least 34 of these students have entered the workforce as M&S professionals, subject matter experts, or educators. At present, there are 99 students currently enrolled in degree programs and another 15 pursuing certificates alone. Since 2014, the number of graduates has nearly tripled, the number of certificates issued has more than doubled, and two new certificate programs have been approved. Some background on the M&S degree and certificate programs is provided as well as outcomes, and a list of recent graduates and their current places of employment. Specific details on each program are appended to the document. These individual program summaries list the key contributing faculty members, describe student progress, and present highlights of faculty and student accomplishments including awards, grant activity, publications, and presentations. The report also describes several challenges faced by the M&S Steering committee in their efforts to manage this university-wide interdisciplinary initiative since its inception. These issues provide valuable lessons learned for thinking about the promotion and management of interdisciplinary programs more generally.

1. Introduction
Old Dominion University is recognized as a world leader in Modeling & Simulation. ODU’s commitment to M&S research and education began with establishing the Virginia Modeling Analysis and Simulation Center (VMASC) in 1997 and creating M&S graduate programs in 1998 followed by the first PhD program in M&S in the USA in the year 2000. More recently, the Modeling, Simulation, and Visualization Department housed within the Batten College of Engineering, was established in 2010.

In 2006-2007, 17 new tenure-track Modeling and Simulation (M&S) faculty positions were created at ODU. Each of the six colleges received at least one new M&S faculty member to engage in M&S research and instruction and cultivate interest in M&S within their respective academic units. During this period, two interdisciplinary M&S committees were established: 1) the Modeling and Simulation Steering Committee, comprised of M&S faculty members appointed from each college, was convened to coordinate and manage pedagogical issues across the university and to oversee the development of core and specialized M&S courses and programs; and 2) the M&S Executive Committee, comprised of the deans from each college, the VP for Research, the Executive Director of
VMASC, and the Vice Provost for Graduate Studies, was created to provide general oversight and governance of the M&S programs.

The Modeling and Simulation Steering Committee has met at least once a month since its formation in August 2007. The M&S Steering Committee initially engaged in conversations about what constitutes Modeling and Simulation faculty, programs, students and courses. The committee established the following definition:

A Modeling and Simulation faculty is a faculty member who is engaged in at least two of the following activities: (1) teaching Modeling and Simulation courses, (2) advising Modeling and Simulation students, and/or (3) Conducting Modeling and Simulation research.

In addition, the committee has reviewed and approved new interdisciplinary graduate M&S degrees and certificates, degree tracks and courses across all the colleges. The committee has also evaluated credentials of faculty certified to teach Modeling and Simulation courses.

The committee has engaged in several promotional initiatives with the goals of increasing interest in M&S research among the ODU community and attracting high-quality graduate students interested in pursuing a career or graduate education in an M&S. Some initiatives include the creation of an M&S graduate student association and an M&S web page (www.odu.edu/academics/programs/multidisciplinary/modsim).

Every year, the committee manages the distribution M&S scholarships provided by funds through the ODU Office of Research. Originally, there were approximately 25 annual scholarships at $18,000 each distributed among the colleges; however, that number has steadily declined since 2015. The scholarships are used to recruit and/or to support PhD students, who are enrolled in a graduate M&S program at ODU. The scholarship can be renewed by the student for a maximum of 3 years. Currently, scholarships are distributed as follows: 10 scholarships go to the MS&V department, the remaining scholarships are distributed based on student credentials and on the needs of the specific M&S programs across ODU. The committee reviews the CVs and M&S statements of interest of the students who receive the scholarships and also assesses the recipients’ accomplishments on a yearly basis. Scholarship recipients are required to present their research progress at the M&S Capstone Conference, usually held at VMASC in the month of April, and they are required to acknowledge the M&S ODU scholarship in every article they present and/or publish.

2. Outcomes

One objective of the M&S Graduate Assistantships is to expand and enhance the M&S workforce in the Commonwealth. This is accomplished by using the assistantships to recruit students who will be enrolled in M&S degree programs, M&S degree tracks, or M&S graduate certificate programs and who, upon graduation, plan to enter the M&S workforce. The M&S workforce includes students planning employment as M&S Professionals/Subject Matter Experts or M&S Educators. A secondary objective is to support the research activities of the M&S faculty who teach regularly in the M&S academic programs, conduct research in which M&S is a primary focus, and mentor students who plan to enter the M&S workforce.

Initial data are shown in Table 1 for the overall number of graduates and certificates awarded. Since the most recent report in 2014, the number of graduates increased from 55 to 156 and the number of certificates issued increased from 57 to 128.

The data in Table 2 show the student progress over the last 7 years among those pursuing degrees or certificates. Again, since 2014 the number of students who completed their certificate requirements increased from 60 to 128.
and the number of students currently pursuing certificates has increased from 13 to 36. Specific details on student accomplishments can be found in the individual program reports.

<table>
<thead>
<tr>
<th>Table 1. Number of M&amp;S Graduates and Certificates Granted</th>
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<tbody>
<tr>
<td><strong>Graduates</strong></td>
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<tr>
<td>MSVE Doctoral Program</td>
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<td>All Other Programs</td>
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<td><strong>Total</strong></td>
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<tr>
<th>Table 2. Student Progress</th>
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</thead>
<tbody>
<tr>
<td><strong>Supported</strong></td>
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<tr>
<td>Number of students who have completed their certificate requirements</td>
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<tr>
<td>Number of students currently pursuing certificates</td>
</tr>
<tr>
<td>Number of graduates</td>
</tr>
<tr>
<td>Number students actively enrolled and working to complete their degrees</td>
</tr>
</tbody>
</table>

* Supported by an M&S scholarship

Although we do not have complete data on where all of the graduates are employed or the types of jobs they have taken, the majority of our 156 graduates have taken positions in the M&S or STEM sector.

**Recent Graduates and Place of Employment**

Sherida Bonton, Analyst, U.S. Army Corps of Engineers, Norfolk, VA  
Warren Howell, Analyst, Norfolk Public Schools, Norfolk, VA  
Antoine Taylor, Senior Analyst, SAIC Corp., Norfolk, VA  
Ryan Clevenger, Systems Analyst III, Epsilon Systems Solutions, Inc., Portsmouth, VA  
Kimberly van Dyke Gilligan, Research scientist, Oak Ridge Laboratory  
Rebecca Sorell, Wargaming analyst for the National Defense University  
Nick Drucker, M&S analyst for Newport News Shipbuilding  
Erika Frydenlund, Assistant Research Professor at VMASC  
Jie Wang, Data Visualization Developer, Bloomberg, New York.  
Krzystof Rechowicz, Assistant Research Professor at VMASC  
Elaine Blount, General Dynamics, Suffolk, VA.  
John Sokolowski, Associate Research Professor, MSVE  
Michael Marin, Department of Electrical Engineering and Computer Science, United Stated Military Academy at West Point  
Sachin Shetty, Associate Research Professor, VMASC and MSVE  
Rafael Diaz, Research Professor and Affiliate at the MIT Center for Transportation & Logistics, Spain  
Bo Sun, Computer Science, Lincoln University, PA  
Robert Robinson, Director of Center for Innovative Transportation Solutions, Old Dominion University  
Charles Turnitsa, Assistant Professor in Engineering & Computer Science, Regent University  
Thomas Holland, Senior Strategist for Modeling and Simulation, Naval Surface Warfare Center Dahlgren  
Elena Craig, Faculty, Old Dominion University.  
John Gounley, Postdoctoral fellow, Institute de Recherche sur les Phenomenes hors Equilibre, Marseilles, France.  
Ibrahim Kocaogul, Adjunct faculty, Old Dominion University.  
Shu Liao; Faculty, Chongqing Technology and Business University in China.  
Panon Phuworawong, Insurance industry analyst in Thailand.  
Sirisha Mushti, Statistician, U.S. Food and Drug Administration.  
Michael Pohrivchak, Scientist, U.S. Naval Research Laboratory.  
Drew S. Posny, Faculty, Wingate University.
3. Challenges

While there has been growing recognition that interdisciplinary work is critical across a range of academic areas, the management of such programs has proven a consistent challenge in the university environment. The more disparate the disciplines across which such work ranges, the more likely there are to be cultural and other differences that make cooperation and evaluation difficult. Even with relatively similar fields, cross-boundary work can be hobbled by the bureaucratic processes that are a necessary part of university administration. Promotion and Tenure guidelines are a particularly critical example of the kinds of processes that are made significantly more complex by faculty who work across boundaries.

Old Dominion University’s efforts to establish a university-wide interdisciplinary approach to modeling and simulation has highlighted some of these challenges, but also provides a useful context for thinking about the promotion and management of interdisciplinary programs more generally.

Modeling and simulation, by its very nature, is an interdisciplinary field of research and teaching. The creation of the MS&V Department within the Batten College of Engineering provided a home for undergraduate and graduate engineering degrees in M&S, but has had only a limited impact on realizing the full potential interdisciplinary research and instructional activities in modeling and simulation at ODU. Likewise, VMASC provides a natural home for many aspects of M&S research. The creation of the Graduate School in 2016 was a positive step for M&S more broadly at ODU by shifting pedagogical issues back to a central unit for more effective oversight and advocacy.

The process of building an interdisciplinary M&S program at ODU has faced a number of challenges, most of which remain ongoing. Most of these challenges are related to the difficulties of creating an interdisciplinary structure within an institutional environment that is organized along disciplinary lines. The institutional challenges for interdisciplinary M&S can be conceptualized in three related areas: support, organizational issues, data issues, and community issues.

Support

Funding support for the M&S scholars has traditionally come from a line item in the commonwealth budget. In the last few years, reductions to this budget line and changes in accounting procedures have significantly reduced the funds available for scholarships. This has had two significant impacts on the scholarship program. First, it has reduced by about 30% the number of students who can be recruited and supported as M&S scholars. Second, it has not allowed the amount of the award ($18,000) to be increased and remain an attractive and competitive means for recruitment. This reduction in support comes at a time, as noted above, when the demand for M&S degrees and certificates at ODU has more than doubled.
Organizational Issues

Interdisciplinary M&S at ODU is organized primarily through the M&S steering committee, as outlined above. This, of course, depends almost entirely on the commitment and volunteerism of a small number of faculty. There is only minimal staff support and there are no real additional resources for producing and promoting cross-campus activities. The committee itself controls no real resources beyond its ability to make recommendations for the M&S scholarships. Faculty members receive little credit for committee service or activities.

While much has been accomplished on a volunteer basis, creating rewards and incentives for interdisciplinary work, both in terms of scholarship and service, continues to be necessary to take this effort to the next level. It is particularly important to develop mechanisms to recognize interdisciplinary work in the process of tenure and promotion.

There are, in fact, a number of institutional roadblocks that make interdisciplinary M&S a more challenging effort. For example, it took literally years, for example, to get a rudimentary cross-campus M&S website up.

A number of other organizational issues can be categorized as problems for data and tracking.

Data Issues

Tracking student majors, progress, and post-graduate employment is difficult in the best of circumstances. It is exceedingly so in an interdisciplinary context. Most of the interdisciplinary M&S program works through the certificate programs, but students are not required to register or otherwise indicate their interest in doing the certificate until they have completed the work. This makes it difficult to keep track of these students.

More generally, there are no flags that would allow cross-campus identification and analysis of M&S students. Following up on students’ graduation and post-graduation plans is a similar challenge. The State is particularly interested in knowing how our M&S works impacts employment opportunities, but we have only limited capabilities for tracking these important outcomes.

The same holds true for classes. Cataloguing the set of M&S classes offered in any semester is a matter of personal communications and coordination among interested faculty. This makes it exceedingly difficult to coordinate times and sequencing of course offerings.

Community Issues

A critical element of solidifying M&S as an area of excellence for ODU is building an authentic community of M&S faculty, students, and alumni. This is made challenging by all of the institutional and data management issues raised above.

We have started coordinating some campus-wide seminars on M&S issues. More effective coordination with VMASC and the MS&V program in engineering, without, in either case, being subsumed is another important challenge.

For these purposes, it would be very helpful to develop a mechanism for positively identifying M&S faculty and students. At the student level, this could be facilitated by tracking core course enrollments. At the faculty level it is more difficult, since there are sometimes competing ideas about what constitutes M&S status. Creating some rewards at the college and university level for contributing to the ODU M&S effort could greatly facilitate this effort.
INDIVIDUAL PROGRAMS

Business Modeling & Simulation

The area of Business Analytics has experienced explosive growth in recent years. An important part of Business Analytics is the use of Modeling and Simulation (M&S) techniques. M&S techniques have been employed in the business and public sectors for over 60 years, often under names such as "operations research", "management science", "decision sciences", "quantitative analysis", and others. The literature of many business and social science disciplines is rich with both practical and theoretical usage of simulation and other quantitative modeling techniques. Recent developments, such as agent-based simulation and virtual worlds, open even more avenues for M&S applicability. These techniques can be utilized to perform analysis and support decision-making in almost all areas of an organization, including supply chain, finance, and market research areas, to name a few. The certificate in Business Modeling and Simulation gives CBPA graduate students an opportunity to develop competency in business-focused quantitative modeling techniques, with a particular focus on simulation modeling.

Key Faculty:

* Dean C. Chatfield, Ph.D., Associate Professor of Information Technology and Decision Sciences, is interested in simulation modeling of supply chains as a means of understanding the inherent volatility in these systems. Dr. Chatfield is also interested in inventory management, meta-heuristic optimization techniques, decision support systems, and open standards for supply chain model storage and sharing. Dr. Chatfield teaches discrete event simulation, agent-based simulation, and operations management.

David Selover, Ph.D., Professor of Economics, studies macroeconomic phenomena, such as the business cycle, and has interests in econometric methods and international economics. Dr. Selover teaches econometrics, international economics, and regularly leads a study-abroad class to study in East Asia.

* administers the CBPA M&S certificate program

Certificates:

The College of Business and Public Administration offers a Graduate Certificate in Business Modeling and Simulation. We have granted certificates to twelve (12) students, including three PhD, four MA, one MBA, and four non-degree students. Our certificate attracts students from other disciplines and colleges, such as Health Sciences and Education. Two students received M&S fellowship funding with the remaining being unfunded. Almost all of the unfunded recipients paid completely out-of-pocket, meaning they were not funded by either M&S fellowships or other types assistantships/funding. Our certificate students have used the Business M&S certificate as a springboard to further education, as a supplement to their current educational endeavors, and as a way to develop quantitative modeling and analysis skills to further their careers in public and private enterprise.

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<thead>
<tr>
<th>Student Progress</th>
<th>Supported</th>
<th>Unsupported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of students completing their certificate requirements</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Total number of students currently pursuing certificates</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Number of graduates (degree-seeking only)*</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Number of non-degree certificate completions†</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Number degree-seeking students actively enrolled and working to complete their degrees</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Number of non-degree students pursuing certificates | 0 | 3

† non-degree seeking students are not part of a graduate program other than the certificate

Current Positions of Certificate Recipients:

Alan Pritchard – Assistant Professor, Texas Tech University, Lubbock, TX
Elizabeth Rasnick – Assistant Professor, Georgia Southern University, Statesboro, GA
Alexis White - PhD student, Old Dominion University
Yi-Ching Lin – Assistant Professor, Virginia State University, Petersburg, VA
Wendell Cruz – Building Services Manager, Old Dominion University
Eric White – Consultant, Booz Allen Hamilton
Sherida Bonton – Analyst, U.S. Army Corps of Engineers, Norfolk, VA
Ronald Greiser – Dominion Capital Partners, Norfolk, VA
Warren Howell – Analyst, Norfolk Public Schools, Norfolk, VA
Antoine Taylor – Senior Analyst, SAIC Corp., Norfolk, VA
Marius Wiedenfeld – Energy Professional, Becker Buttner Held Consulting AG, Berlin, Germany
Ryan Clevenger - Systems Analyst III, Epsilon Systems Solutions, Inc., Portsmouth, VA

Faculty Highlights (activities facilitated by the M&S assistantship program):

Student Highlights:

• **Alan Pritchard** accepted a position as Assistant Professor at Texas Tech University in 2017.
• **Elizabeth Rasnick** accepted a position as Assistant Professor at Georgia Southern University in 2015.
• **Alan Pritchard** was admitted to two top-tier supply-chain PhD programs and began studies at the University of Maryland (a top-5 doctoral program in the area) in Fall 2013.
• **Marius Wiedenfeld** works as an Energy Professional with Becker Buttner Held Consulting AG in Berlin, Germany, 2016.
• **Marius Wiedenfeld** won a scholarship for M&S work entitled "Peak oil predictions and its impacts - myth or reality?" by the University of Strathclyde and was admitted to their Global Energy Management masters degree program.
• **Elizabeth Rasnick** presented “Simulating the Bullwhip Effect in a Multi-echelon Supply Chain” at the 2015 Modeling, Simulation, and Visualization Capstone Conference.
• **Elizabeth Rasnick** presented “Information Blackouts in a Multi-Echelon Supply Chain Simulation” at the 2017 *Winter Simulation Conference*, Las Vegas, NV, December 3-6, 2017.
• **Elizabeth Rasnick** presented “The Impact of Information Blackouts on the Bullwhip Effect” at the 2016 Annual Meeting of the Decision Sciences Institute, Austin, TX. (November 19-22, 2016)
• **Elizabeth Rasnick** presented “Technology Adoption in the Home Inspection Industry” at the 2012 Meeting of the Decision Sciences Institute, San Francisco, CA, 2012.

Faculty Interdisciplinary M&S activities:


Dean C. Chatfield, editorial board member of
• *International Journal of Business Analytics* (IJBAN, 2012 – present),
• *European Journal of Industrial Engineering* (EJIE, 2009 - present),
• *International Journal of Integrated Supply Management* (IJISM, 2012 - present),
• *International Journal or Operations Research and Information Systems* (IJORIS, 2008 – present)

Dean C. Chatfield, reviewer for approximately 20 different peer-review academic journals including International Journal of Simulation and Process Modeling (IJSIM) and Simulation Modeling Practice and Theory (SIMPAT) as well as flagship journals such as Production and Operations Management (POM) and Decision Sciences.

Dean C. Chatfield, member of ODU M&S Steering Committee (2007 - present).

Dean C. Chatfield, reviewed several NSF grant proposals in the area of supply chain simulation (2008 – present).

Dean C. Chatfield, student research advising for two CBPA students (departments of Economics and Information Technology)

Dean C. Chatfield, thesis/dissertation committee member for four graduate students from outside the CBPA (one from Health Sciences, three from BCET)

Modeling & Simulation in Education & Training

Simulations, games, and modeling tools are used extensively to facilitate learning and practice in education and training environments. The Darden College of Education offers a certificate in M&S through the Instructional Design and Technology program, a graduate-level program that is part of the STEM Education and Professional Studies Department. The M&S Simulation Certification in Education and Training provides students with a theoretical background and applied skills for the design, development, selection, integration, and evaluation of modeling and simulation techniques and tools for learning in K-12 through adult instructional settings. This certificate was the first of its kind in the U.S. and is a natural concentration area in ID&T given the widespread use of simulation and gaming as instructional tools in Pre-K-12 education, colleges, universities, and corporate and military training programs.

Key Faculty:

- *John Baaki, Ph.D., Assistant Professor, with research interests on taking an empathic design approach to the design and development of instructional design and human performance initiatives including simulation, gaming and virtual environments. Dr. Baaki teaches courses in needs assessment, foundations of distance education, advanced instructional techniques, non-instructional interventions, human performance technology and instructional design theory.

- *Karina Arcaute, Ph.D., Assistant Professor, who teaches in the Industrial Technology Program. Dr. Arcaute does research related to rapid prototyping and STEM and engineering education. She teaches courses in the area of STEM education, medical, agricultural, and biological technologies.

* administers the M&S certificate program in Education & Training

Certificates:

Fellowship support for students in the M&S Certificate in Education and Training program began in 2009. To date, seven students who have enrolled in the program have received M&S graduate student fellowship funding. Of these five completed their certificate requirements and one additional student will complete the certificate this year. One student who received funding failed to complete the certificate. An additional 13 students enrolled in the certificate program and 12 of these have received certificates. One will receive her certificate this year.

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<tr>
<th>Student Progress</th>
<th>Supported</th>
<th>Unsupported</th>
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<tbody>
<tr>
<td>Number of students who have completed their certificate requirements</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Number of students currently pursuing certificates</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Number of graduates</td>
<td>5†</td>
<td></td>
</tr>
<tr>
<td>Number students actively enrolled and working to complete their degrees</td>
<td>1</td>
<td>1</td>
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† 1 students withdrew from the program

Graduates and Current Positions:

Dr. Enilda Romero-Hall, Assistant Professor, Instructional Design & Technology Program, College of Social Sciences, Mathematics, & Education, University of Tampa, Tampa, FL

Dr. Jennifer Morrison, Assistant Professor-Clinical, Center for Technology in Education (CTE), John Hopkins University, Baltimore, MD

Dr. Don Robison, Instructional Designer, Eastern Virginia Medical School (EVMS), Norfolk, VA – Collecting Dissertation at US Coast Guard, Fall 2014. Expected Graduation, spring 2015.
Dr. Jana Eggleston, Doctoral Student, Ph.D. in Ecological Sciences, Department of Biological Sciences, College of Sciences, Old Dominion University

Dr.. Yi-Ching (Gloria) Lin, Doctoral Student, Ph.D. in Occupational & Technical Studies, Darden College of Education, Old Dominion University. Preparing to complete comprehensive exams in spring 2015.

**Current Status of Funded Students:**
Mr. Joshua Stubbs, Doctoral Student, Ph.D. in Instructional Design and Technology, Darden College of Education, Old Dominion University

**Faculty Highlights (grants, awards, patents, facilitated by the M&S assistantship program):**


Katsioloudis, P., **Watson, G.S.**, Papelis, Y.E., & Reed, P.A. *Visualization of Port Logistics: VisPort©*. Opportunity, Inc. $122,000 (August 1, 2009 – June 30, 2010).


**Watson, Ginger S.**. *Shipboard Simulator and Motion Sickness Mitigation*. Grant application submitted in partnership with SA Photonics as part of a Small Business Technology Transfer (STTR) proposal N08-T011-0036 submitted to NAVAIR. Phase I - $21,000. (July 14, 2008 – February 14, 2009)

**Key Student Highlights (awards, key articles, major presentations, internships, grants; students in bold type)**


Refereed Journal Publications


Refereed Conference Proceedings


Refereed Presentations


Faculty Interdisciplinary M&S activities

Ginger S. Watson, Chair, M&S Steering committee, (2012-2013)

Ginger S. Watson, Member, M&S Steering committee, (2007-present)


Ginger S. Watson, Electronic Field Trip Experts Focus Group Member, Colonial Williamsburg, (2012).

International Studies

Overview

The Graduate Program in International Studies is an interdisciplinary social sciences program that recently celebrated its 25th anniversary at Old Dominion University. The program has twelve faculty members and admits approximately 25 MA and PhD students per year.

Modeling and Simulation has grown rapidly over the past twenty-years as a cutting-edge approach to understanding international relations. Game theory and agent-based modeling have a particularly rich history in international studies and have contributed a number of significant insights into the dynamics of conflict and cooperation at the international level.

GPIS has been involved in the interdisciplinary Modeling and Simulation effort from its earliest stages at Old Dominion University. For several years, VMASC and GPIS collaborated on a set of conversations and a colloquium series on the challenge of human behavioral modeling. This effort culminated in a set of significant DoD grants for work Human Behavioral Modeling and on Bayesian Network Analysis. Beginning in about 2010, GPIS has developed a specialized modeling and simulation track in both the MA and PhD programs. GPIS also grants a certificate in Modeling and Simulation.

GPIS currently offers four graduate courses in Modeling and Simulation:

IS762/862 – Game Theory for International Studies (Richman)
IS765/865 – Agent-Based Modeling & Simulation for International Studies (Frydenlund)
IS795/895 – Geographic Information Science for International Studies (Liu)
IS795/895 – Modeling and Simulation Theory for International Studies (Wu)

In addition, GPIS M&S students have taken a range of classes in other departments across the University, including coursework in decision modeling, risk analysis, instructional simulation, modeling global events, combat modeling, big data, and principles of visualization.

Key Faculty

Erika Frydenlund, VMASC
Hua Liu, Department of Political Science and Geography
Jesse Richman, Department of Political Science and Geography
Cathy Wu, Department of Political Science and Geography

The Numbers

In the time since the November 2014 report, ten GPIS students have completed the requirements for the certificate in Modeling and Simulation. Four MA students have graduated with Modeling and Simulation as their primary track. Five PhD students have completed PhDs with Modeling and Simulation as one of their concentrations, and five other PhD students have successfully passed their field comprehensive exam in Modeling and Simulation.

Prior to November 2014, GPIS had awarded seven certificates in Modeling and Simulation. Four MA students had graduated with Modeling and Simulation as their primary track. Four PhD students had included Modeling and Simulation as one of their concentrations and successfully passed their field comprehensive exam in Modeling and Simulation.

Many other students have benefited from the opportunity to take the classes in game theory, agent-based modeling and geographic information science.
Student Progress

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<tr>
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<th>Supported</th>
<th>Unsupported</th>
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<tbody>
<tr>
<td>Total number of students completing their certificate requirements</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Total number of students currently pursuing certificates</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Number of graduates (degree-seeking only)†</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Number of non-degree certificate completions‡</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Number degree-seeking students actively enrolled and working to complete their degrees</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Number of non-degree students pursuing certificates</td>
<td>0</td>
<td>1</td>
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† non-degree seeking students are not part of a graduate program other than the certificate

Modeling and Simulation Student Highlights

GPIS M&S students have consistently participated in the M&S capstone conference and have been awarded best paper and best presentation prizes. They have also presented their work at regional and national conferences in both international studies and in modeling and simulation.

Our students have also found the M&S concentration to be a potent addition for their employment profile. One of our first M&S fellowship recipients, Kimberly van Dyke Gilligan is now a research scientist at the Brookhaven National Laboratory working on nuclear non-proliferation issues. Rebecca Sorell, who was one of our first M&S certificate recipients, is now a wargaming analyst for the National Defense University, and also pursuing the PhD with an M&S concentration. Another M&S certificate holder, Nick Drucker, is working as an M&S analyst for Newport News Shipbuilding. Erika Frydenlund is using her M&S skills as a Senior Project Scientist at VMASC. Several of our other M&S students have also held internship and research positions at VMASC. Jan Nalaskowski is KMD Business Scientist at Cambridge Social Science Decision Lab in Washington DC. Samantha Golden is a Department of State Frasue-Kruzel-Drew (FKD) Fellow.

Interdisciplinary or multidisciplinary M&S Activities

The Graduate Program in International Studies is, itself, an interdisciplinary program. It pulls together faculty across the social sciences, as well as from several fields in the humanities. The addition of interdisciplinary modeling and simulation has been a very natural fit.

In addition to collaborative projects with VMASC, we are also looking to increase our cooperation with the College of Business and Public Administration and the College of Engineering.
Health Care Modeling & Simulation

Modeling and Simulation in Health Care is a very diverse discipline and it involves several research techniques that can relevant to health services. For example, approaches of Modeling and Simulation can be used to train health care workers, track the spread of the disease, evaluate public health policy, provide virtual reality based interventions, and predict health outcomes.

Key faculty:

Steven Morrison, PhD

Dr. Morrison is an Endowed Professor and Director of Research within the School of Physical Therapy and Athletic Training at Old Dominion University. Currently, Dr. Morrison serves as the graduate program director of the Certificate in Modeling and Simulation in Health Care. He received his PhD from the Pennsylvania State University in 1997 and undergraduate and Master’s degrees in Physiology and Kinesiology from the University of Otago, New Zealand. Dr. Morrison has a broad background in Motor Control, Neurophysiology, and Biomechanics with particular focus as to how the control of movement changes as a function of aging and disease. A primary area of research interest is related to falls, particularly with regards to the implications changes in the pattern of gait, balance control and/or physiological function has for overall falls risk. This line of research addresses the varied risk factors that emerge as a function of the normal process of aging and for clinical populations such as Parkinson’s disease, type 2 Diabetes, and multiple sclerosis.

Certificate:

Support for students in the Certificate in Modeling and Simulation in Health Care began in 2008. To date, 14 students have enrolled in the program and completed their certificate requirements. Only 9 students were supported on M&S fellowships. The majority of students enrolled in the Certificate in Modeling and Simulation in Health Care are graduate students who are pursuing a PhD in Health Service Research at the College of Health Sciences.

<table>
<thead>
<tr>
<th>Student Progress</th>
<th>Supported</th>
<th>Unsupported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students who have completed their certificate requirements</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>Number of students currently pursuing certificates</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Number of graduates</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Number students actively enrolled and working to complete their degrees</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Current Positions of Certificate Recipients:

Emily Hartley – Lecturer, School of Physical Therapy and Athletic Training, ODU

Faculty Highlights (grants, awards, patents, facilitated by the M&S assistantship program):

Grants

Gaff, H (PI) and K. Goodman (M&S fellow). Virginia Commonwealth University Center on Health Disparities. $3000 for dissertation research support.

**Student Highlights (awards, key articles, major presentations, internships, grants; students in bold type)**


**Diggs LA**, Viswakula D., De Leo G. A Multivariate Model to Predict Endotracheal Intubation Success by Paramedics in the Out-of-Hospital Setting. Capstone Conference 2014, April 17, Suffolk, VA (Best presentation in the Medical Track)

**Barrios-Padrino C**, McCombs G., Diawara N., De Leo G. The Use of Interactive Immersive Visualization for the Control of Dental Anxiety During Dental Hygiene Treatment. Capstone Conference 2013, April 11, Suffolk, VA (Best presentation in the Gaming & Virtual Reality Track)


Faculty Interdisciplinary M&S activities

Steven Morrison, M&S Steering committee member, (2016-present)
Matt Hoch, M&S Steering committee member, (2013-2016)
Gian Luca De Leo M&S Steering committee member, (2006-2013)
Modeling, Simulation, and Visualization Engineering (MSVE) Department

Highlights and Activities of M&S Degrees (undergraduate and graduate) and Graduate Certificates

Summer 2014

The MSVE Department was started in 2010 to support ODU’s new Bachelor of Science (B.S.) in Modeling and Simulation Engineering (M&SE) degree program. Since M&S programs at the graduate level have existed at ODU since 1998, an established cadre of motivated faculty, administrators, and M&S stakeholders were readily available to draw upon in the establishment of the undergraduate program and the Department.

ODU’s sojourn into graduate modeling and simulation programs was initially administered by Dr. Ralph Rogers who, a year earlier, had headed a workshop [1] on the subject while at the Department of Industrial Engineering and Management Systems at the University of Central Florida. His arrival at ODU spurred on the establishment of the first PhD program in M&S in the USA in the year 2000 and the first PhD graduate in M&S in 2003. A year after Dr. Rogers’ workshop, teaching M&S at the undergraduate level was the theme at a 1998 National Science Foundation (NSF) workshop in Vancouver, Canada [2]. Inspiringly, Sarjoughian and Zeigler (2001) broached the subject of teaching M&S as an undergraduate discipline. Later, in 2006, the NSF Blue Ribbon Panel on Simulation-Based Engineering Science (SBES) [4] stated that “seldom have so many independent studies by experts from diverse perspectives been in such agreement: computer simulation has and will continue to have an enormous impact on all areas of engineering, scientific discovery, and endeavors to solve major societal problems.”

Several years after pioneering a successful graduate program and building significant M&S infrastructure, we became the first in the world M&S department established specifically to support a B.S. program in the M&S discipline. Currently, the MSVE Department offers a full spectrum of academic programs. At the undergraduate level, we offer a Bachelor of Science Degree in Modeling and Simulation Engineering and a Minor in M&S for students majoring in other disciplines. At the graduate level, the Department offers a Graduate Certificate in M&S; Master of Science (thesis option) and Master of Engineering (non-thesis option) Degrees in M&S; and Doctor of Engineering (practitioner option) and Doctor of Philosophy (research option) Degrees in M&S.

Several universities have developed tracks or concentrations focusing on narrow sub-areas of modeling and simulation as part of other degree programs; however, to date, no accredited engineering program in modeling and simulation has been fully implemented. At the outset, ODU's undergraduate M&SE program has been designed to meet four sources of program content and goals [5, 6]: the ABET criteria for accrediting engineering programs; the literature defining an M&S body of knowledge [7, 8]; a set of discipline-specific student outcomes identified by program faculty; and university general education requirements. The result is a curriculum that teaches the fundamental principles and theoretical foundations of M&S and prepares students to enter the workforce as entry-level modeling and simulation engineers. In addition, graduates will be prepared to enter graduate study in modeling and simulation and, with appropriate choice of program electives, other disciplines where modeling and simulation has application. M&SE graduates also will be prepared for certification via the Certified Modeling & Simulation Professional (CMSP) examination (www.simprofessional.org) and licensure as an Engineer in Training (EIT).

Besides these various degree options, MSVE offers graduate certificates in M&S. The Graduate Certificate in Modeling and Simulation Engineering is designed for those who meet the admission requirements of the modeling and simulation master's program who wish to broaden their knowledge of modeling and simulation related principles and practices without pursuing a graduate degree. This is a 12 credit hour non-degree program offered by the Department of Modeling Simulation and Visualization Engineering (MSVE). The certificate program is open to both degree-seeking and non-degree-seeking graduate students. Courses taken for the certificate program may later be applied to the master's degree in modeling and simulation.

<table>
<thead>
<tr>
<th>Student Progress</th>
<th>Supported</th>
<th>Unsupported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current students who have completed the certificate</td>
<td>0</td>
<td>35</td>
</tr>
</tbody>
</table>
Students currently pursuing the certificate | 0 | 15
Graduates who have completed the certificate | 14 | 95
Total enrolled graduate students | 10 | 63

### M&S Certificate Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSIM 601 - Introduction to Modeling and Simulation</td>
<td>3 credits</td>
</tr>
<tr>
<td>MSIM 602 - Simulation Fundamentals</td>
<td>3 credits</td>
</tr>
<tr>
<td>One course from the following below: • MSIM 510 - Model Engineering • MSIM 541 - Computer Graphics and Visualization • MSIM 551 - Analysis for M&amp;S • MSIM 603 - Simulation Design</td>
<td>3 credits</td>
</tr>
<tr>
<td>MSIM Elective - An approved graduate level elective course</td>
<td>3 credits</td>
</tr>
</tbody>
</table>

An overall GPA of 3.0 or better is required to earn the certificate.

### Course Descriptions

The following are catalog descriptions for the M&S courses listed above:

**MSIM 601. Introduction to Modeling and Simulation.** Lecture 3 hours; 3 credits. First course for modeling and simulation graduate students. Modeling and simulation discipline surveyed at an overview level of detail. Definitions, paradigms, applications, and sub-disciplines are introduced. Orient students to the Modeling and Simulation Graduate Program and provides a general conceptual framework for further MSIM studies.

**MSIM 602. Simulation Fundamentals.** Lecture, 3 hours; 3 credits. An introduction to the modeling and simulation discipline. Introduction to discrete event simulation (DES) including simulation methodology, input data modeling, output data analysis, and an overview of DES tools. Introduction to continuous simulation (CS) including simulation methodology, differential equation models, numerical solution techniques, and an overview of CS tools.

**MSIM 510. Model Engineering.** Lecture, 3 hours; 3 credits. The goal of this course is to develop understanding of the various modeling paradigms appropriate for capturing system behavior and conducting digital computer simulation of many types of systems. The techniques and concepts discussed typically include UML, concept graphs, Bayesian nets, Markov models, Petri nets, system dynamics, Bond graphs, etc. Students will report on a particular technique and team to implement a chosen system model.

**MSIM 541. Computer Graphics and Visualization.** Lecture, 3 hours; 3 credits. An introduction to graphical systems and methods. Topics include surfaces, solids, and realism techniques such as visible surface, lighting, shadows, and surface detail. Applications to modeling and simulation including 2-D and 3-D solid models, data visualization, and animation.

**MSIM 551. Analysis for Modeling and Simulation.** Lecture, 3 hours; 3 credits. An introduction to analysis techniques appropriate to the conduct of modeling and simulation studies. Topics include input modeling, random number generation, output analysis, variance reduction techniques, and experimental design. In addition, techniques for verification & validation are introduced. Course concepts are applied to real systems and data.
MSIM 603. Simulation Design. Lecture, 3 hours; 3 credits. Course develops the computer software skills necessary for the design and development of simulation software. Topics covered include software architectures, software engineering, software design, object-oriented programming, abstract data types and classes, data structures, algorithms, and testing and debugging techniques. Software design and development of simulation systems (discrete-event, continuous, and Monte Carlo) are emphasized.

The following are catalog descriptions for courses that may be also used for the MSIM Elective:

MSIM 506. Introduction to Distributed Simulation. Lecture, 3 hours; 3 credits. An introduction to distributed simulation. Topics include motivation for using distributed simulation, distributed simulation architectures, time management issues, and distributed simulation approaches. Current standards for distributed simulation are presented.

MSIM 660. System Architecture and Modeling. Lecture 3 hours; 3 credits. Students will learn the essential aspects of the system architecture paradigm through environment and analysis of multiple architecture framework and enterprise engineering, such as IDEFO, TOGAF, DODAF and OPM. Emphasis on system modeling and enterprise engineering.


MSIM 741. Principles of Visualization. Lecture, 3 hours; 3 credits. Well-designed graphical media capitalizes on human facilities for processing visual information and thereby improves comprehension, memory, inference, and decision making. This course teaches techniques and algorithms for creating effective visualizations based on principles and techniques from graphic design, visual art, perceptual psychology and cognitive science. Both users and developers of visualization tools and systems will benefit from this course.

Key Faculty

<table>
<thead>
<tr>
<th>Faculty Name</th>
<th>Area of Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audette, Michel</td>
<td>Medical applications in M&amp;S including imaging and surgery.</td>
</tr>
<tr>
<td>Leathrum, James</td>
<td>Parallel and distributed simulation, hardware and software simulation architectures, and applications of discrete event simulation to multi-modal transportation systems.</td>
</tr>
<tr>
<td>Madan, Bharat</td>
<td>Network and cyber security applications.</td>
</tr>
<tr>
<td>McKenzie, Frederic</td>
<td>Medical modeling and simulation, human behavior representation, and simulation architectures often focusing on aspects of scientific visualization and virtual reality.</td>
</tr>
<tr>
<td>Mielke, Roland</td>
<td>Systems theory, mathematical modeling, modeling and simulation education, application of continuous simulation in electrical engineering, and applications of discrete event simulation in transportation and enterprise decision support.</td>
</tr>
<tr>
<td>Noor, Ahmed</td>
<td>Computational mechanics, multi-scale modeling and simulation, interactive visual simulation, and advanced simulation-based learning environments.</td>
</tr>
<tr>
<td>Shen, Yuzhong</td>
<td>Game-based learning; visualization and computer graphics; modeling and simulation; and, signal and image processing.</td>
</tr>
<tr>
<td>Sokolowski, John</td>
<td>Human behavior modeling; decision system modeling; multiagent system simulation; and, modeling and simulation representation of social systems</td>
</tr>
</tbody>
</table>
In addition to our department faculty, MSVE collaborates closely with the Virginia Modeling, Analysis and Simulation Center (VMASC). VMASC researchers serve as research collaborators, graduate adjunct faculty, and ambassadors for M&S and the MSVE Department. Additionally, MSVE graduate students often are supported on VMASC research projects.

**Modeling and Simulation Graduate Program**

Since its commencement in 1997, Modeling and Simulation Graduate Program has awarded 52 Master of Science degrees, 100 Master of Engineering degrees, 22 Ph.D. degrees, and 5 graduate certificates. Since 2010, MSVE received 10 M&S graduate assistantships each year. Among the students who have received the M&S assistantships, four were awarded Ph.D. degrees, two were awarded Master of Engineering degrees, seven are in ABD (All But Defense) status, five have passed the Diagnostic Exam, and four are still taking courses.

**Graduates Supported on M&S Fellowships and Current Positions:**

- Dr. Jie Wang, Data Visualization Developer, Bloomberg, New York.
- Dr. Krzysztof Rechowicz, Visiting Assistant Professor, Old Dominion University, Commonwealth Center for Advanced Manufacturing, Disputanta, Virginia.
- Dr. Elaine Blount, General Dynamics, Suffolk, VA.
- Dr. Aras Rifat, 2014 graduate.

**Other Notable M&S Graduates**

- Dr. John Sokolowski, Executive Director, Virginia Modeling, Analysis, and Simulation Center, Old Dominion University.
- Dr. Michael Martin, Assistant Professor, Department of Electrical Engineering and Computer Science, United Stated Military Academy at West Point.
- Dr. Sachin Shetty, Assistant Professor, Department of Electrical and Computer Engineering, Tennessee State University.
- Dr. Rafael Diaz, Research Associate Professor, Virginia Modeling, Analysis, and Simulation Center.
- Dr. Bo Sun, Assistant Professor of Computer Science, Lincoln University, PA
- Dr. Robert Robinson, Director of Center for Innovative Transportation Solutions, Old Dominion University.
- Dr. Charles Turnitsa, Assistant Professor, School of Computer Science, Columbus State University
- Dr. Thomas Holland, Senior Strategist for Modeling and Simulation, Naval Surface Warfare Center Dahlgren,

**Faculty Highlights (grants, awards, patents, facilitated by the M&S assistantship program):**

Development of a Patient-Specific Spine Modeling and Surgery Simulation, Jeffress Memorial Trust, PI Michel Audette, $100,000, 07/1/2013 – 06/30/2014.
Haptic-Enabled Simulator for a NUSS Procedure Planner and Trainer, Children’s Hospital of the King’s Daughters (CHKD) - Children’s Surgical Specialty Group (CSSG), PI Rick McKenzie, $285,000 August 2012 – Spring 2014.


Shen, Y. (Co-PI). Improving Programming and Financial Literacy Education Using Student-Developed Games, National Science Foundation, 2011-2014, $200,000.

Parodi, A. (PI), Diallo, S., Scerbo, M.W., & Papelis, Y. LIVES and SIM Lab (Laboratory of Investigation, Validation and Verification of Emerging Simulators). EVMS, 2012. $50,000.

Papelis, Y. (PI), Scerbo, M.W., & Garcia, H.M. Virtual Operating Room. EVMS, 2012-present, $55,875.

**Student Highlights (awards, key articles, major presentations, internships, grants; students in bold type)**


Afrose, Z., Best Paper, Gaming and Virtual Reality Track, Modeling and Simulation Capstone Conference, 2014

Aras, R., Graduate Travel Award, Old Dominion University, 2012.


**Faculty Interdisciplinary M&S activities**

Yuzhong Shen, ODU Gaming HUB, (2014-present)
John Sokolowski, Member, Governor’s Modeling and Simulation Advisory Board
John Sokolowski, Member, Executive Committee, National Modeling and Simulation Coalition
Mark W. Scerbo, Vice Chair, Society for Simulation in Healthcare, Research and Scientific Contents Committee (2012 – present)
Mark W. Scerbo, co-PI, Multidisciplinary Modeling and Simulation Program, IGERT proposal (2009), NSF, (unfunded)

**2013 MSVE Graduate Student Publications** (Calendar Year 2013 Only)
(13 journal papers, 2 book chapters, 29 conference papers)

Journal Papers


Book Chapters


Conference Papers

1. **Mohammad F. Obeid and John Shull**, “West Nile Virus System Dynamics Investigation in Dallas County, TX”, 2013 Winter Simulation Conference


REFERENCES


Computer Science Department Information for M&S

Key Faculty Members with research interests

**Andrey Chernikov** is an Associate Professor in the Department of Computer Science. His expertise is in mesh generation, including such aspects of it as parallelism and scalability, computational geometric proofs of quality guarantees, high order, anisotropy, as well as a new direction of formal methods and certified code generation.

**Nikos Chrisochoides** is the Cheng Endowed Chair in the Department of Computer Science. Professor Chrisochoides' research activities are focused on: (i) Medical Image Computing, namely real-time deformable registration for image guided neurosurgery and (ii) High Performance Computing with focus on Exascale and Quantum Computing, specifically extreme-scale Finite Element adaptive anisotropic mesh generation for aerospace applications.

**Jing He** is a Professor in the Department of Computer Science. Her research interests include Bioinformatics and Computational Biology, Protein Bioinformatics including Protein Structure Prediction and Determination using cryoEM Images, and Image Pattern Recognition using Machine Learning.

**Yaohang Li** is an Associate Professor in the Department of Computer Science. His research interests are Computational Biology, Monte Carlo Methods, Big Data Analysis and Parallel/Distributed/Grid Computing.

**Desh Ranjan** is an Endowed Professor in the Department of Computer Science. His research interests include Design and Analysis of Efficient Sequential and Parallel Algorithms, Parallel and High-Performance Computing, Computational Complexity, Computational Biology and Bioinformatics, Computational Physics.

**Michele Weigle** is a Professor in the Department of Computer Science. Her current research interests are Web Science, Digital Preservation, and Information Visualization.

**Mohammad Zubair** is a Professor in the Department of Computer Science. His research interests include Big Data Analytics, Parallel Computing and High Performance Computing in the areas of Econometrics, Financial, Bioinformatics, and Scientific Computing.

Numbers

Number students actively enrolled and working to complete their degrees
 Supported – 6* (4 currently supported by M&S Fellowship, 2 in the past) Unsupported - 0

<table>
<thead>
<tr>
<th>Student Progress</th>
<th>Supported</th>
<th>Unsupported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students who have completed their certificate requirements</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Number of students currently pursuing certificates</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Number of graduates</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Number students actively enrolled and working to complete their degrees</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

Graduated Students


Dong Si (He) Ph.D. 2015. University of Washington, Bothell, Assistant Professor, Computing and Software Systems

Hao Ji (Li), PhD 2016. California State Polytechnic University, Pomona, Assistant Professor, Computer Science Department

**Grants Facilitated by M&S Fellowships**

1. NSF: A novel framework for developing highly scalable and energy efficient guaranteed quality mesh generation for 3D and 4D finite element analysis: Case study Delaunay method (Chrisochoides).

**Awards**

Best paper Award, Summer Sim 2015, 47th Summer Computer Simulation Conference (SCSC 2015) Kamesh Arumugam.

Lee Entsminger College of Science Outstanding PhD Dissertation Award for 2017-18: Kamesh Arumugam.

Numerous awards to multiple CS students for presentations at Annual VMASC Capstone Conference.
Computational and Applied Mathematics Modeling and Simulation

The Department of Mathematics and Statistics at Old Dominion University holds the unique distinction of being the only department in the Commonwealth of Virginia to offer B.S., M.S. and Ph.D. degrees in Computational and Applied Mathematics. As computational mathematics, or computational science in general, plays a greater role in every branch of the science, the department is equipped with programs which are designed to produce computational and applied mathematicians, statisticians and teachers with analytical and computational skills necessary to meet the challenges of the modern society. The department plays an integral part in University's campus-wide initiative to promote its research in Simulation and Modeling. Our simulation faculty currently conduct research in the following areas:

- Computational fluid dynamics, nonlinear heat conduction problem, computational aeroacoustics, complex fluids, nematic polymer dynamics, non-equilibrium hypersonic flow, hydrodynamic stability.
- Computational and mathematical biology, mathematical modeling of tumor growth, cancer biology, bioinformatics, optimal atomic configurations of biomolecules,
- Computational Statistics, multivariate analysis, regression diagnostics, probability theory.

Students enrolled in the MS or PhD program may earn the Modeling and Simulation Certificate, with concentration in either Computational and Applied Mathematics or Statistics, by completing an approved 12 credit hour course of study.

Key Faculty:

John Adam, Ph.D.; mathematical modeling, theoretical meteorological optics.
N. Rao Chaganty, Ph.D.; large deviations, generalized linear models, estimating equations.
Norou Diawara, Ph.D.; multivariate analysis, modeling, probability theory, estimation.
Fang Hu, Ph.D.; computational fluids with emphasis on turbulent mixing.
Sookyung Joo, Ph.D.; soft matter systems, liquid crystals, partial differential equations.
Hideaki Kaneko, Ph.D.; wavelets, numerical analysis of integral equations, finite element analysis, discontinuous Galerkin methods.
Li-Shi Luo, Ph.D.; kinetic theory and nonequilibrium statistical mechanics, lattice Boltzmann equation and CFD, complex fluids.
Kayoung Park, Ph.D.; survival analysis, joint modeling of survival and longitudinal data, and statistical quality control.
Yan Peng, Ph.D.; fluid dynamics, lattice Boltzmann equation, gas kinetic scheme, high performance computation.
Lucia Tabacu, Ph.D.; nonparametric statistics, rank based methods, quantile estimation, biostatistics.
Jin Wang, Ph.D.; numerical analysis, scientific computation, fluid dynamics, mathematical biology.
Nail Yamaleev, Ph.D.: Entropy stable spectral collocation methods, Grid adaptation based on error minimization, Reduced-order modeling, Adjoint-based optimization methods, Computational fluid dynamics.
Ruhai Zhou, Ph.D.; numerical analysis, scientific computation, numerical simulations of liquid crystalline polymers and nano-composite materials.
Certificates:

Support for students in the Computational and Applied Mathematics M&S Certificate Program began in 2008. To date, 10 students have completed the certification requirements. 14 students have been supported by an M&S scholarship.

<table>
<thead>
<tr>
<th>Supported</th>
<th>Unsupported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current students who have completed the certificate</td>
<td>2</td>
</tr>
<tr>
<td>Students currently pursuing the certificate</td>
<td>3</td>
</tr>
<tr>
<td>Graduates who have completed the certificate</td>
<td>8</td>
</tr>
<tr>
<td>Total enrolled graduate students</td>
<td>4</td>
</tr>
</tbody>
</table>

Graduates and Current Positions:

Elena Craig, Ph.D.; faculty, Old Dominion University.-A

John Gounley, Ph.D.; Postdoctoral fellow, Institute de Recherche sur les Phenomenes hors Equilibre, Marseilles, France.-A

Ibrahim Kocaogul, Ph.D.; adjunct faculty, Old Dominion University.-A

Shu Liao; faculty, Chongqing Technology and Business University in China.-A

Panon Phuworawong, Ph.D.; insurance industry analyst in Thailand.-I

Sirisha Mushti, Ph.D.; Statistician, U.S. Food and Drug Administration.-I

Michael Pohrivchak, Ph.D.; Scientist, U.S. Naval Research Laboratory.-I

Drew S. Posny, Ph.D.; faculty, Wingate University.-A

Manasi Sheth-Chandra, Ph.D.

Traci Ann Sievenpiper, Ph.D.; faculty, LaSalle College.-A

Asim Timalsina, Ph.D.: Data Analyst, Carfax, Inc.-I

Xingwang Chen, Ph.D.: Instructor, Savannah State University -A

Wei Li, Ph.D.: PostDoc, Tsinghua University, Shenzhen, China - A

Amanda Working, Ph.D.: Statistician, ODU Research Foundation – I/E

Pooja Sengupta, Ph.D.: Assistant Professor, International Management Institute, Kolkata -A

Faculty Highlights (grants facilitated by the M&S Program):

Fang Hu, PI. 9/1/2008-8/31/2012, $120,846, Title: Analysis and implementation of accurate numerical boundary conditions for Large Eddy Simulations and the Boltzmann equation, funded by National Science Foundation, Division of Mathematical Sciences, ODURF# 382611.

Fang Hu, PI. 9/1/2008-8/31/2012, $120,846, Title: Analysis and implementation of accurate numerical boundary conditions for Large Eddy Simulations and the Boltzmann equation, funded by National Science Foundation, Division of Mathematical Sciences, ODURF# 382611.

L.-S. Luo (PI) and A. Beskok. A Unified Modeling Approach for Micro- and Nano-Scale Gas Flows, NSF DMS-0807983, $256,000, 07/01/2008 - 06/30/2012.

L.-S. Luo (PI), W. Liao, and Y. Peng. Computing Using General Purpose Graphic Processing Units, Grant from NASA Langley Research Center through an SSAI Contract NNL08AA00C, $30,000, 06/24/2008 - 10/31/2009.

NSF CBETS-1029428, $15,000, 09/01/2010 - 08/31/2011.
NSF CBETS-0827259, $13,000, 06/01/2008 - 05/30/2009.
NSF CBETS-0733134, $15,000, 07/01/2007 - 06/30/2008.


L. Greene (PI), L.-S. Luo, A. Pothen, C. Osgood, and P. Hatcher. Elucidation of Protein Structure Networks and Beyond, ODU-RF, $80,000 (01/01 - 06/30/2008).

Yan Peng, PI. $213,903, National Science Foundation, #DMS-1319078.

Yan Peng, PI. $70,599, ODU Internal Grant, ODURF #503921.


Zhou, R. Collaborative Research: Kinetic to Continuum Modeling of Active Anisotropic Fields. National Science Foundation. $120,800. (September 15, 2015 – August 30, 2018).

Student Highlights

Publications:


Shi, Baochang; Deng, Bin; Du, Rui; Chen, Xingwang; A new scheme for source term in LBGK model for
convection-diffusion equation. (English summary)


J. Gounley and Y. Peng, Shape recovery of elastic capsules from shear flow induced deformation, accepted by Communications in Computations Physics, November 2013.

J. Gounley and Y. Peng, Response and recovery times of elastic and viscoelastic capsules in shear flow, in revision.

J. Gounley and Y. Peng, Computational modeling of membrane viscosity of red blood cells, in revision.


Mushti, Sirisha; Analysis of continuous longitudinal data with ARMA(1, 1) and antedependence correlation structures.


M.G. Forest, P. **Phuworawong**, Q. Wang, R. Zhou, Phil. Transactions A, "Rheological signatures in limit cycle behavior of dilute, active, polar LCPs in steady shear", accepted.


D. **Posny** and J. Wang, Computing the basic reproductive numbers for epidemiological models in nonhomogeneous environments. In revision.


**Presentations:**


**John Gounley**, Contributed Talk: *Computational Modeling of Membrane Viscosity of Red Blood Cells* Old Dominion University SIAM Student Chapter Conference, Norfolk, VA, April 2014.


**John Gounley**, Contributed Talk: *A three-dimensional model of viscoelastic capsule deformation* Old Dominion University SIAM Student Chapter Conference, Norfolk, VA, April 2013.


**John Gounley**, Contributed Talk: *Shape recovery of viscoelastic capsules from shear flow induced deformation* Graduate Student Colloquium, Old Dominion University, Norfolk, VA, September 2012.


**John Gounley**, Contributed Talk: *Modeling the shape deformation and recovery of red blood cells using the lattice Boltzmann method*. Old Dominion University SIAM Student Chapter Conference, Norfolk, VA, March 2012.


**John Gounley**, Contributed Talk: *A method for interface computing of two-phase Stokes flow in three dimensions* Old Dominion University SIAM Student Chapter Conference, Norfolk, VA, April 2011.


**Sirisha Mushti**, “Analysis of longitudinal data using ARMA (1, 1) correlation model.” SIAM Conference, March 24, 2012, Norfolk, VA.
Sirisha Mushti, “Analysis of longitudinal data using ARMA (1, 1) correlation model.” ENAR Spring Meeting, April 1-4, 2012, Washington, DC.

Sirisha Mushti, “Pairwise likelihood approach for analyzing longitudinal data using a robust correlation structure.” VAS 2012 Meeting, May 24, 2012, Norfolk, VA.

Sirisha Mushti, “Modeling and Analysis of continuous longitudinal data using ante-dependence correlation structure”. 2013 Student Capstone Conference, April 11, 2013, Suffolk, VA.

Sirisha Mushti, “Pairwise likelihood method for analyzing continuous longitudinal data using ARMA(1,1) correlation structure.” SIAM Conference, April 13, 2013, Norfolk, VA.


Awards:


John Gounley, SIAM Student Travel Award for SIAM-AN12, 2012

John Gounley, Travel support for Graduate Student Mathematical Modeling Camp, 2011

John Gounley, ODU Philip R. Wohl Graduate Scholarship, 2011


Human Factors Psychology Modeling & Simulation

Human factors is a discipline in which principles of cognition, information processing, learning, and perception are applied to the design of technology. Knowledge of human factors helps create a better match between user capabilities and system demand; an understanding of human capabilities helps designers generate more veridical models of human behavior; and applying principles of human factors can create more effective simulator training systems. The Modeling and Simulation Certificate Program provides students with a focus on psychological principles that address end-user issues, with models of human behavior, and with knowledge/skill acquisition.

Key Faculty:
* Mark W. Scerbo, Professor, is interested in the development and evaluation of healthcare simulation technology. He also studies virtual reality systems and virtual environments and performance with adaptive technology. Dr. Scerbo teaches courses in sensation and perception, human factors, and virtual environments.

James Bliss Ph.D., Professor, studies the occurrence of alarm (and automation) mistrust, compliance with automated systems, human-robot interaction, and the use of virtual environments for training complex tasks such as surgery, firefighting, soldiering, and navigating unfamiliar environments. Dr. Bliss teaches courses in sensation and perception, learning, ergonomics, and safety.

Jeremiah D. Still, Ph.D., Asst. Professor. Dr. Still specializes in Human-Computer Interaction. His research focuses on developing human-centered authentication interfaces, improving intuitive design theory, and using computational models of visual saliency to predict fixations within interfaces.

Yusuke Yamani, Ph.D., Asst. Professor. Dr. Yamani explores mechanisms of attention and how they constrain human performance in basic and applied environments. His current research focuses on human-automation interaction, eye movements of young and older drivers, and operators’ trust toward automated systems.

Jing Chen, Ph.D., Asst. Professor. Dr. Chen investigates the fundamental principles of human performance and decision-making, and applies these principles to real-world problems. Her current research focuses on safety-critical systems such as semi-autonomous driving systems and phishing detection systems in the cyber space.

* administers the HFP M&S certificate program

Certificates:
Support for students in the Human Factors Psychology M&S certificate program began in 2008. To date, 6 students have enrolled in the program and completed their certificate requirements. All students who received certificates were supported on M&S fellowships.

<table>
<thead>
<tr>
<th>Student Progress</th>
<th>Supported</th>
<th>Unsupported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students who have completed their certificate requirements</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>Number of students currently pursuing certificates</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Number of graduates</td>
<td>3†</td>
<td>1</td>
</tr>
<tr>
<td>Number students actively enrolled and working to complete their degrees</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

† 3 students withdrew from the program

Graduates and Current Positions:
Dr. Erik Prytz, Research Scientist, Swedish Institute for Computer Science, Linköping University, Sweden - A
Dr. T. Robert Turner, User Experience Research Lead. Luminex Corporation, Austin, TX
Dr. Rebecca A. Kennedy - Agrilyst Inc., New York, NY.

Faculty Highlights (grants, awards, patents, facilitated by the M&S assistantship program):


Parodi, A. (PI), Diallo, S., Scerbo, M.W., & Papelis, Y. LIVES and SIM Lab (Laboratory of Investigation, Validation and Verification of Emerging Simulators). EVMS, 2012. $50,000.


Papelis, Y. (PI), Scerbo, M.W., & Garcia, H.M. Virtual Operating Room. EVMS, 2016, $55,875.


Student Highlights (awards, key articles, major presentations, internships, grants; students in bold type)

Turner, T. R., Human Factors & Ergonomics Society Student Member with Honors Award, 2009

Turner, T. R., Best Paper, Health & Medicine Track, MODSIM World Conference & Expo, 2010

Kennedy, R.A., 3rd Place, Medical and Healthcare Track, ODU M&S Capstone Student Conference, Suffolk, VA 2011.

Kennedy, K.D., 3rd Place, Medical and Healthcare Track, ODU M&S Capstone Student Conference, Suffolk, VA 2011.

Outstanding Technology Abstract – 2nd Place, International Meeting on Simulation in Healthcare

Outstanding Technology & Program Innovation Abstract – 2nd Place, International Meeting on Simulation in Healthcare

Outstanding Research Abstract – 4th Place, International Meeting on Simulation in Healthcare

Erik Prytz, Best Paper award in the Education & Training track at the ODU M&S Capstone Student Conference, Suffolk, VA, 2012.
Outstanding Research Abstract – 2nd Place, International Meeting on Simulation in Healthcare

**Prytz, E., Montano, M., Kennedy, R., Scerbo, M., Britt, R., Davis, S., & Stefanidis, D. (Jan. 2013).** Using a spatial task to measure laparoscopic mental workload: Initial Results. The 13th International Meeting on Simulation in Healthcare, Orlando, FL.

**Other Scholarly Productivity**


**Faculty Interdisciplinary M&S activities**
Mark W. Scerbo, Chair, M&S Steering committee, (2013–present)
Mark W. Scerbo, co-PI, Multidisciplinary Modeling and Simulation Program, IGERT proposal (2009), NSF, (unfunded)
Mark W. Scerbo, Elected Fellow of the Society for Simulation in Healthcare, 2016
Mark W. Scerbo, Vice Chair, Society for Simulation in Healthcare, Research and Scientific Contents Committee (2012–2016)
Mark W. Scerbo, Member, EVMS Center for Surgical Education Advisory Board, (2011–present)
Mark W. Scerbo, Member, Sentara Center for Simulation and Immersive Learning Advisory Committee, (2014–present)
Mark W. Scerbo, Member, Society for Simulation in Healthcare Fellows Academy Scholarship Committee, (2017–present)
Modeling & Simulation in Ocean Earth & Atmospheric Sciences (OEAS)

The research in oceanography that involves M&S includes area such as numerical modeling of ocean circulation, biogeochemical models and ecosystem models. Various data from ocean observations and satellites are analyzed using M&S techniques and visualization. The OEAS department offers a graduate certificate in M&S in Ocean Earth and Atmospheric Sciences. Most of this research is done by faculty, postdocs and graduate students at the Center for Coastal Physical Oceanography (CCPO), with support from external sources such as NSF, NOAA and NASA and internal support from the Climate Change and Sea Level Rise Initiative since 2012 and ODU’s Resilience Collaborative since 2017.

Key Faculty: (see http://www.ccpo.odu.edu/ for more details)
* Tal Ezer, Ph.D., Professor of Ocean Earth and Atmospheric Sciences. Research interests focused on computational ocean circulation modeling and various processes in physical oceanography. In recent years research focused on climate change, sea level rise and the increased risk of flooding in the Hampton Roads and around the US. coasts.

John Klinck, Ph.D., Professor of Ocean Earth and Atmospheric Sciences and director of CCPO. Research interests include dynamics in physical oceanography, numerical models of ocean circulation, Antarctic sea-ice and ecosystem models.

Eileen Hofmann, Ph.D., Professor of Ocean Earth and Atmospheric Sciences. Research interest focused on coupled physical-biological models and physical-biological interactions in marine ecosystems, climate control of diseases of marine populations, and mathematical modeling of marine ecosystems.

* administers the M&S certificate program in OEAS

Other Activities:
Ezer is an editor for Ocean Dynamics, editor for special issues in Ocean Modelling and organizer of the International Workshop on Modeling the Ocean. He also manages and maintains the website of the Princeton Ocean Model Users Group of some 5000 users from 70 countries. Other key faculty serve as editors of major scientific journals and manage various large projects that involve M&S aspects.

Certificates:
While Ezer has been affiliated with VMASC and the M&S program since 2007, official certificate in M&S in OEAS was only approved in 2017. In the past, 2 graduate students obtained partial support from M&S (both graduated already before 2010); currently no student is supported by M&S, though a dozen or so graduate students in the department may be involved in M&S-related research under various external grants and different projects

The M&S certificate in OEAS includes the following classes:
Required:
MSIM 601 Introduction to Modeling & Simulation (3 credits)
OEAS 551 Data Collection and Analysis in Oceanography (4 credits)
OEAS 605 Introduction to Ocean Modeling and Prediction (3 credits)
 Restricted Elective (select one):
OEAS 519 Spatial Analysis of Coastal Environments (3 credits)
OEAS 704 Time Series in Oceanography (3 credits)
OEAS 708 Simulation Techniques for Ocean Circulation (3 credits)
OEAS 755 Mathematical Modeling of Marine Ecosystems (3 credits)
Selected Recent Refereed Journal Publications That Involve M&S Aspects

(none supported directly by M&S grants; ODU faculty, researchers and students are marked)


Modeling & Simulation in Biological Sciences

The research in biological sciences that involves M&S includes area such as modeling of numerous systems including marine conservation and vector-borne diseases, biogeography models for animal movements, and statistical models of animal behavior. These models are supported through a variety of field and laboratory studies to provide estimates of key parameters that drive these systems. The Department of Biological Sciences offers a graduate certificate in M&S in Biological Sciences. M&S-related research is done by faculty, postdocs and graduate students across the department with support from external sources such as NSF, NIH, USDA, and ONR.

Key Faculty:
Holly Gaff, Ph.D., Associate Professor of Biological Sciences. Research interests focused on the ecology of ticks and tick-borne diseases through a long-term ecological surveillance project that supports the development and continued refinement of mathematical models to inform health risks in the Hampton Roads area and beyond.

Mark Butler, Ph.D., Professor and Eminent Scholar of Biological Sciences. Research interests include ecology of shallow, tropical marine ecosystems and the impacts of anthropogenic disturbance on ecosystem structure and dynamics; the biology and ecology of Caribbean spiny lobster with practical implications for fisheries management, and restoration ecology as applied to tropical marine ecosystems, with particular emphasis on shallow, tropical hard-bottom communities and coral patch reefs.

Sara Maxwell, Ph.D., Assistant Professor of Biological Sciences. Research interest focused on the interaction between large marine predators, particularly seabirds, sea turtles, marine mammals and sharks, and human uses of the oceans such as wind energy, marine fisheries, and cumulative impacts of human activities. Her work focuses on determining the effectiveness of management techniques such as marine protected areas, marine spatial planning, and dynamic ocean management using novel tools and technologies such as animal-borne technology and habitat modeling.

Eric Walters, Ph.D., Associate Professor of Biological Sciences. Research program encompasses facets of community ecology, theoretical ecology, conservation biology, and evolution. He uses a variety of scientific approaches to integrate applied, theoretical, and basic research. Methods of investigation include field experiments, long-term demographic studies, and mathematical modeling in order to understand how species interact with each other and their environment; all within a larger conservation biology framework.

Other Activities:
Other departmental faculty are engaged in related areas of quantitative biology such as bioinformatics.

Certificates:
While Gaff was hired as a M&S-affiliated faculty in 2007, the official certificate in M&S in Biological Sciences is in the process of being approved (currently in Academic Affairs office). In the past, four PhD students in the department obtained partial support from M&S; two have graduated, one will graduate this spring, and the other is in her first year. The first three students all completed a M&S certificate from another department.

The M&S certificate in Biological Sciences includes the following classes:
Required:
MSIM 601 Introduction to Modeling & Simulation (3 credits)
BIOL 772/872 Modeling and Simulation in the Life Sciences (4 Credits).

Electives:
BIOL 707/807 Ecosystem Ecology (5 Credits)
BIOL 732/832 GIS in the Life Sciences (3 Credits)
Other M&S classes as approved by GPD.