Modeling and Simulation
Academic Program
M&S Workforce Development

Partners in Providing World-Class M&S Education for Hampton Roads

Commonwealth Of Virginia

Old Dominion University

Virginia Community Colleges

Public School Systems

Associate of Science Degree
TCC; TNCC

Associate of Applied Science Degree

Bachelor's Degree
ODU

Master's Degrees
ODU

Doctoral Degrees
ODU

Scientist
Research, Development

Engineer
Design, Analysis

Technologist
Implementation, Operations

Technician
Maintenance, Support

High School Diploma
Virginia Beach ATC

M&S will be nearly a $1B Enterprise in Hampton Roads By 2010
### M&S Program Productivity

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VMASC Research
Engaging VMASC Researchers

- Periodic applied research area meetings (military/homeland security, medical and health care, transportation)
- VMASC web site
- VMASC news letter
- VMASC summary of awarded research projects
Transportation
Currently Funded Projects

- VDOT Volume Delay Functions
- Hampton Roads Transportation Alternatives
- Norfolk Signal Light Delay
VDOT Volume Delay Functions

- Three primary equation forms
- Factors include road volume, capacity, physical road characteristics, time of day
- Which of the equations (or a hybrid) best represents observed flows?
- Apply revisions to Hampton Roads, Fredericksburg, Charlottesville
Hampton Roads Transportation Alternatives

- Peak-hour congestion model
- Primary arterials included in analysis
- Refined accident-incident forecast (location, frequency, and severity)
- Recurrent and incident induced congestion analysis
- Direct, objective ranking using transportation metrics
- December 2010
Traffic Signal Priority for the Tide Light Rail System

- Safe and efficient operations of both highway vehicles and LRT trains
- Special signal control mode for the servicing railroad crossings, emergency vehicle passage, mass transit vehicle passage, and other special tasks
Unfunded Research

Evacuation Simulations

- Congested conditions decisions
- Accident and incident injection
- Presentations to Transportation Research Board Annual Meeting (DC) and National Evacuation Conference (New Orleans)

Transportation simulation dynamic traffic additions
Work in Planning
Maritime Port Security

Universities of Genoa and Calabria

Three main sections

- Shipping to/from terminal
- Internal terminal operations
- Freight transfer from terminal (trucking, rail)

Threat identification and simulation

- Information fusion analysis

Initial goal – training.
VMASC
Old Dominion University

Research Focus: Medical & Health Care

by
Mohammed M Ferdjallah, Ph.D.
Research Associate Professor
Dr. Gaff’s Research Projects

- **Tick-Borne Diseases: Rift Valley Fever – Modeling and Bio-surveillance** (*NIH-K25*)
  - *ODU, Johns Hopkins, U. Maryland, U. Michigan*

- **Optimal Strategies for Controlling Cholera Outbreaks** (*NSF*)
  - *ODU, Murray State U., Marymount U., U. Tennessee*
Dr. Scerbo’s Research Projects

- Surgical Workload Assessment Task
  - ODU, EVMS

- Detection Accuracy for Maternal-Fetal Heart Rate Tracings
  - ODU, EVMS

- Selection Instrument for Standardized Patients
  - ODU, EVMS
Dr. Ringleb’s Research Projects

- Developing an internet based rehabilitation program for war-fighters with functional hearing loss secondary to blast and/or mTBI (OSD, SBIR-phase I and II)
  - ODU

- Developing VR assessment modules to determine return to duty and affective (OSD)
  - ODU

- Improving VR based rehabilitation systems to treat stroke patients and collecting fMRI data on these patients (ODU’s Office of Research)
Dr. De Leo’s Research Projects

• GaMeTT: Create a computer game-based software tool to track, assess, and train medical support teams to operate under stressful conditions. (Mymic LLC)
  • VMASC/ODU, Mymic LLC, Forterra Inc

• Iphone Application for Emergency Preparedness (Hampton Roads Planning District Commission)
  • VMASC/ODU
Dr. McKenzie’s VMASC-Related Research Projects

- Virtual Pathology Stethoscope
  - ODU, EVMS

- Augmented Standardized Patient EKG Tracking
  - ODU, EVMS

- Virtual Pathology Sonography
  - ODU, EVMS
Dr. Ferdjallah’s Research Projects

- Monarch Virtual Hospital Project
  - Nursing/ODU, VMASC/ODU
- Proton Therapy Modeling & Simulation (pending)
  - VMASC/ODU, PTI/HU
- Diabetic Data Mining (pending)
  - VMASC/ODU, EVMS
Dr. Ferdjallah’s Research Projects

- Electromagnetic Interferences Modeling & Simulation (*pending*)
  - VMASC/ODU,

- Virtual Patient Library (*working project*)
  - VMASC/ODU, EVMS

- Assessment of Virtual Online Learning & Training (*working project*)
  - VMASC/ODU, English/ODU
Virtual Environments
Focus Areas

All aspects of virtual environment modeling

- Agent-Based modeling
  - Human behavior modeling
  - Task and performance modeling
  - Autonomous systems

- Virtual environment representation
  - 3D visual representations
  - Semantic modeling

- Immersive virtual environments
  - Driving/flight simulation
Example Project – NASA Air-Ops Lab

- Enhance NASA Air-Ops Lab
  - Augment autonomous pilot model with hardware inceptors
  - Develop high fidelity visual model of Dallas/Ft. Worth airport
  - Integrate with NASA software to provide simulator out-the-window view
  - Enhance aircraft model to support landing
Dallas/Ft. Worth Model
Example Project – Port Simulation

- Sponsored by Opportunity Inc., addressing immersive demonstration of Port careers

- Develop game-like simulation of port operations

- Allow user to “take-on” various roles
  - Crane/transtrainer operator, longshoreman, coordinator etc.

- Project utilizes rich multi-media combined with 3D environment
Selected Port is NIT

- Supported operations include: tugboat ship guidance, crane scheduling, container unloading, sea and land-side container movement.
Example Project – Crowd Modeling

- Various sponsors
- Fusion of cognitive and physical movement model
- Higher fidelity than the simple movement models used in planning & evacuation
Crowd effort highlights

- Active Denial System demonstration
- Flow field use for short-term guidance
- Cognitive model driving social-forces movement behavior
Military/Homeland Security
National Program for Small Unit of Excellence

Vision: A National Program that advances the tactical art of high performing small units that when unleashed can operate autonomously in regular and irregular complex environments and prevail every time.

Mission: The National Program for Small Unit Excellence serves as the hub for cross-community integration of military and civilian communities of practice to focus on the problem sets for enabling small unit excellence, providing collaborative knowledge-management, fora and venues to present and debate new research for unleashing the power of small units and to transition new competencies, concepts and capabilities with metrics and assessments to small units.

Research, provide assessments, transition planning, planning support documents, recommendation papers, and briefings on development services in support of the Center.

Recent Hire: Mr. James Stacia
VMASC NPSUE Program Manager
Hampton Roads Urban Area Working Group (UAWG)
Urban Areas Security Initiative (UASI)

Investment Justification (IJ) Prioritization Methodology

FY2010

Team VMASC
- Dr. Barry Ezell, ODU
- Ms. Heather Warren Noell, EBR
- Mr. Donald G. Owen, EBR
- Ms. Lisa Izuma, LMCO
Bioterrorism I Assessment

- Project Number: 702981
- Sponsor: Battelle National Biodefense Institute
- Principal Investigator: Dr. Barry Ezell

2006-2010

2012
Additional Projects Underway

- **JTEOW/JCOM** - development of processes and products to help with a Joint Common Object Model
  - an architectural neutral method for federating systems (C2 and M&S)
  - development of a Joint Warfare Taxonomy that can be used as metadata for semantic search across existing solutions in a repository (a customer would search this repository to see if existing Object Model candidates serve his need).

- **PEO Soldier** - making a federation of US Army entity level simulators working with the new MATREX Federation Object Model (FOM) work together
  - identifying Primitives of Meaning that define doctrinal tasks and actions, and then using that analysis to modify the FOM to allow for representing these primitives, so that other doctrinal tasks can be composed easily
  - Research based on Turnista’s findings from 2006 Masters Thesis

- **CBML** - this project, under the BattleLab support contract, is in support of the Coalition Battle Management Language standardization effort.
  - VMASC's role: to ensure that the needs and requirements and capabilities of JFCOM work done at the Joint Advanced Training Technologies Laboratory, JATTL is represented in the standardization process, and also to bring back findings from the standardization work to JFCOM

**PI: Dr. Andreas Tolk**
**Project Scientist: Chuck Turnitsa**
Additional Research Activity

- Guest speakers from Hampton Roads, DHS and DoD on analytic challenges facing the government (4-6 weeks)

- Risk-informed Decision Making Course Development (3 day, 24 hour hands-on for managers and analysts)
Business & Supply Chain
Content

Research:
- Supply Chain and Reverse Logistics
- Throughput and Resource Allocation
- Economic/Environmental Impact Modeling

Looking ahead
Supply Chain and Reverse Logistics

Warehouse simulation study: Combining Optimization and Simulation for improving material handling

- Combined Optimization and Zoning Simulation: Correlations, Throughput, and weighs
- Invited: International Journal of Production Economics - Special Issue

Educating Supply Chain, Reverse Logistics, and M&S

- In the U.S. Logistics Cost: $950 billion/year
- Return Costs 5%: $43 billion/year
- Empty containers costs globally 7.9 billion/year
- Spring 2010

Flapper et al. 2005
Throughput and Resource Allocation

Innovative JIT / CONWIP production systems
- Analyzed and designed intelligent priority rules for Job Shops and Flow Shops
- Reduce waiting time 40%-60%
- Reduce WIP inventory up to 5%
- Published: Journal of Production and Operations Management (2 more papers)

An Application of Simulation-based Optimization in ER's Resource Allocation
- Reduced Length of Stay (LOS)

A System Dynamic Approach to Modeling the Sensitivity of Inappropriate Emergency Department Utilization
- Presented: INFORMS 2009 - San Diego, CA
System Dynamics Simulation Model

**Sub-model: Environmental Impact**

- Normal moving in rate
- Effect on moving in
- Birth rate
- Moving in
- Death rate
- Moving out
- Normal moving out rate
- Effect on moving out
- Percent of travel satisfied by mass transportation
- Percent of travel using car, van, truck
- Life expectancy
- Average number of trips per day per capita
- Total travel demand
- Volume of personal vehicles on road
- Traveled distances increase due to population increase
- Average distance per trip
- Vehilces occupancy rate
- Actual vehicles occupancy rate
- New vehicle occupancy rate
- Time frame
- Volume / Capacity

**Sub-model: Economic Impact**

- Time frame
- Normal moving in rate
- Normal moving out rate
- Effect on immigration
- Time fraction

**Volume / Capacity**

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**“Volume / Capacity” : Current**

**Effect on moving in**

- Time frame
- Presently

**Presented: ModSim World 2009 – Virginia Beach, VA**
Looking Ahead

- Capstone conference - April 2010
- POMS – Vancouver, Canada. May 2010
- Course: Supply Chain and Reverse Logistics – Spring 2010
- Routing Optimization
- Economic Impact Transportation
  Way/Infrastructure projects
- Reverse Logistics
Game-based Learning Update

Dr. Yuzhong Shen, Assistant Professor
Dept. of Electrical and Computer Engineering (ECE)
Virginia Modeling, Analysis, and Simulation Center (VMASC)
Using Xbox 360 for Rehabilitation of Brain Injured Patients

- SBIR Phase I with MYMIC LLC.
- Sponsored by Office of the Secretary of Defense, DoD.
- Improve patients’ cognitive and motor skills.
Virtual VMASC

- Sponsored by VMASC.
- Provides virtual tour, directory, and other information of VMASC using gaming technologies.
2009 ODU Game Development Summer Camp

- Held June 22 to 26, 2009
- 20 participants from 6 cities of Hampton Roads.
- Taught Game Maker, Google SketchUp, and Google SketchyPhysics.
- Reported by WAVY 10 and Daily Press.
Course: Introduction to Game Development

- Offered in Spring 2009 at both undergraduate and graduate levels for the first time.
- C# and Microsoft XNA Game Studio were utilized.
- Students developed educational games.
- Games can be played on Windows PC, Microsoft Xbox 360, and Zune
Social Science
Case Studies

- **Insurgency Modeling**—complex model of population dynamics
- **Colombia**—war on drugs . . . population dynamics
- **Nigeria**—oil, poverty, corruption . . . in a pivotal state
- **Afghanistan**—opium, religion, state-building . . . amidst conspiracy theories
- **Ireland**—Easter Rising 1916 and Anglo-Irish War . . . unequal protagonists
Modeling Global Events: A Focus on Insurgency

A model for stability and reconstruction
Nigeria

black circles represent the oil assets, yellow the tribesmen, green represents the police forces, orange for insurgents

Agent Cellular Grid
what if . . . reduce the *max coercive acts* parameter, which governs the number of coercive acts committed by each British soldier on a monthly basis.

result was based on a value of 0.2 for this parameter.

Suppose the British government implemented a policy that better controlled how the soldiers behaved and the number of acts was reduced to 0.1 acts per soldier.
Agent–based Modeling: Personifying the Agent

- A Social Sciences methodology to objectively personify agents

- Agent-based modeling is intrinsically social; actions and characteristics of the agents are influenced by the actions and characteristics of the other agents in the social system.

- Fundamental aspects of agent-based modeling, a necessary paradigm for characterizing, assessing, and validating global events, call attention to the precision needed in developing the key component: the agent.

I am, therefore I think.
Getting Theoretical . . .

Advancing Game Theory

- Integrating theory and concepts with endgame state engagements

Political Theory/Concepts | Outcome of State Engagements
---|---
deterrence | status quo
| | acquiesce
| | negotiation
compellence | capitulate
| | war

Political Theory/Concepts | Pay-off of State Engagements
---|---
will | utility
| capability | capability
| commitment | salience
Getting Theoretical . . .

Engaging Multi-Modeling Paradigms
- transitioning from SD, ABM, GT, and SN Modeling to holistically, non-deterministically, and continuously represent a real-world event

Social Network Modeling
- exploring the criminal infrastructure vis-à-vis migration
- assessing disruptive communication vis-à-vis gang and terrorist organizations
Embrace M&S as a discipline and as a serious problem solving and decision support tool.

Leverage new developments in M&S to provide solutions to the marketplace and conduct collaborative research with academia.

Develop new M&S IP to help solve complex problems for industry and government and to provide industry with the basis for new product development. Provide knowledgeable students to industry and government as part of the workforce development process.