



Modeling and Simulation is a critical element of most Defense related programs. Yet many technical problems persist -- and more importantly, modeling and simulation products often do not meet practical requirements for mainstream use, greatly limiting their effectiveness. Founded in 1996 by Michael Zyda, MOVES is addressing the most critical problems in modeling and simulation towards bringing M&S products to their full potential for training, analysis, and acquisition. Our areas of concentration include training, networked visual simulation, computer-generated autonomy, human performance engineering, game-based simulation, and combat modeling and analysis. MOVES is also a graduate degree program for military officers and civilians. Their expertise and practical know-how make MOVES special and help us to work towards bringing simulation and training products to every day use for the warfighter. This is a sample of MOVES projects. For more information, please visit <http://www.movesinstitute.org>

Come to the MOVES Open House -- August 16-18 2005

-- Rudy Darken, Director

Extensible Modeling & Simulation Framework

Define a composable set of standards, profiles and recommended practices for web-based Modeling & Simulation (M&S), enabling simulations to interact directly and scalably over a highly distributed network, achieved through compatibility between a web framework and networking technologies. (DMSO)

-- Don Brutzman brutzman@nps.edu



VIRTE:

Virtual Technologies & Environments

Develop deployable training solutions for the fleet. We are prototyping and experimenting with a wide variety of deployable training systems for helicopter pilots and crew, Marine Corps infantry and Forward Observers. (ONR)

-- Rudy Darken darken@nps.edu



Understanding for Autonomous Agents

To build autonomous agents for virtual environments that understand the situations they find themselves in to an unprecedented degree, and leveraging this into the ability to understand natural language. Modeling elements of subconscious cognition such as associative memory, perception, and motor processing and rigorous characterization of the developed techniques. (NAVMSMO) -- Chris Darken cjdarken@nps.edu

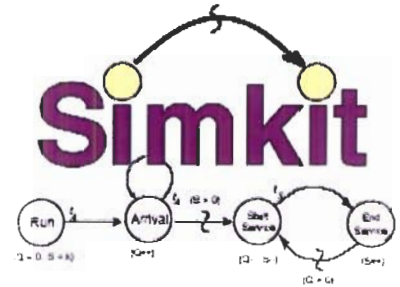


Simkit

Simkit is an Open Source package for creating Discrete Event Simulation (DES) models written in Java 2™. Simkit is used at NPS and MOVES to teach DES. The labs and tutorials are available on-line. You can download the distribution at

<http://diana.gi.nps.navy.mil/Simkit>.

-- Arnie Buss abuss@nps.edu



Online Mentors

Develop an exemplar training scenario using standards-based approach for use in language and cultural familiarization across DoD and US Government departments. The vision of vast numbers of trainees receiving this vital training anywhere, anytime is achievable through this cooperative development. (JADL-CoLab) -- Don Brutzman brutzman@nps.edu



AEGOS:

Automatic Evolutionary Scenario Generation

Use genetic processes to evolve batches of scenarios using preferences obtained from users. Leverages earlier work on red-team intent, cognitive blending, and multi-agent systems. This work is essential to the development of readily available training systems so that scenarios will not be repeated, maximizing the variability of the training experience.

-- John Hiles jehiles@nps.edu



Delta3D: Open Source Game & Simulation Engine

Develop an Open Source game engine that is robust, full-featured, general purpose (cross-genre), and supportable for Defense training and education. Delta3D radically changes the business model of training system development by commoditizing the run-time environment. It is fully Open Source encouraging maximum reuse of code and models.

(NETC, NAVMSMO, JNTC) -- Rudy Darken darken@nps.edu



The MOVES MS Program* 18-24 Months (Depending on background)

First Year

- Object-Oriented Programming
- Probability and Statistics
- Human Factors System Design
- Simulation and Training
- Joint Combat Modeling
- Network Communications for Simulation
- System Simulation
- Artificial Intelligence
- Computer Graphics Programming, Modeling

Second Year (choose 3 focus areas)

- Combat Modeling
- Networked Visual Simulation
- Web-Based Simulation
- Agents and Cognitive Modeling
- Training Systems
- Human Factors
- Management and Acquisition
- Physically-Based Modeling
- Optimization

* PhD program also available



THE MOVES INSTITUTE

NAVAL POSTGRADUATE SCHOOL

MOVES INSTITUTE OPEN HOUSE 2005

Tuesday, August 16, 2005

- 1200-1300 Registration, Coffee
- 1300-1330 *Welcome, MOVES In Transition*
Rudy Darken
- 1330-1345 *SAVAGE Project Overview featuring: USW-XML, Waterside Security (WSS) and Extensible Modeling and Simulation Framework (XMSF)*
Don Brutzman
- 1345-1400 *Autonomous Unmanned Vehicle (AUV) Workbench*
Don Brutzman, Jeff Weekley
- 1400-1415 *Autonomous Vehicle Control Language (AVCL)*
CDR Duane Davis, USN
- 1415-1430 *AUV Workbench Environmental Services / Super Computer Modeling*
Peter Flynn, Don Brutzman, Don McGregor
- 1430-1500 Break
- 1500-1515 *Simkit (Past, Present and Future)*
Arnie Buss
- 1515-1530 *Viskit/Diskit*
Rick Goldberg (Anaviza), Mike Bailey
- 1530-1545 *Gridkit Cluster Operations*
Don McGregor, Rick Goldberg (Anaviza), Don Brutzman
- 1545-1615 *Waterside Security (WSS), and Savage Modeling and Analysis Language (SMAL)*
Don Brutzman, David Colleen (Plant 9), Alan Hudson (Yumetech), Rick Goldberg (Anaviza) and Mike Bailey
- 1615-1630 *Extensible 3D Graphics (X3D) Advanced Features*
Alan Hudson (Yumetech), Don Brutzman, Jeff Weekley
- 1630-1900 Reception

Wednesday, August 17, 2005

- 0730-0800 Registration, Coffee
- 0800-0820 *Algorithms for Sourceless Orientation Measurement*
Eric Bachmann, Xiaoping Yun
- 0820-0845 *Internet2 Initiatives at NPS*
Terri Brutzman
- 0845-0910 *Towards Learned Anticipation in Complex Stochastic Environments*
Chris Darken
- 0910-0925 *Focus of Attention with Compound Multiagent Systems (CMAS) & Unscripted, Ambiguous Wargames*
Arnie Buss (for John Hiles)

- 0925-1000 *Suspicious Behavior in Air Defense and Urban Warfare*
Neil Rowe & John Custy
- 1000-1030 Break
- 1030-1050 *Event Prediction for Modeling Mental Simulation in NDM*
LtCol Dietmar Kunde, German Army
- 1050-1120 *Where Navy Modeling & Simulation is Going*
John Moore, Director, NMSO
- 1120-1140 *Computer Vision for Training, Surveillance, and Everything Else*
Mathias Kölsch
- 1140-1200 *Modeling Critical Infrastructures*
Ted Lewis, Rudy Darken, LtCol Waleed Al Mannai, Bahrainian Air Force
- 1200-1300 Lunch (on your own)
- 1300-1330 *ADL Initiative and Gaming Technologies*
Mike Freeman, Deputy Director, ADL Initiative
- 1330-1350 *A Sneak Peek at the Delta3D Game Engine Release 1.0*
Erik Johnson
- 1350-1410 *GENETICS: High Resolution Terrain Generation*
Maj David "Fuzzy" Wells, USAF
- 1410-1430 *FOPCSIM: Forward Observer Trainer*
Maj J.P. McDonough, USMC, Capt Mark Strom, USMC
- 1430-1500 Break
- 1500-1530 *Gaming at the Army War College*
LTC Rene Burgess, USA (MOVES Graduate, 2003)
- 1530-1550 *Training Squad Leaders Using Games*
Maj Joe Nolan, USA, Maj Jason Jones, USA
- 1550-1610 *Cleared Hot: Forward Air Controller (Airborne) Trainer*
Maj Charles Lakey, USMC, Maj Gregory King, USMC
- 1610-1630 *Helicopter Flight Simulation for the FAA*
CDR Joe Sullivan, USN
- 1630-1900 Demo Night

Thursday, August 18, 2005

- 0730-0800 Registration, Coffee
- 0800-0815 *Modeling and Simulation (M&S), Military Operations Other than War (MOOTW), Flexible Asymmetric Simulation Toolkit (FAST)*
Curt Blais
- 0815-0830 *Common Maneuver Network (CMN) and Mobility Common Operating Picture (M-COP)*
Curt Blais, MAJ Willis, USA (TRAC)
- 0830-0850 *Human Systems Integration and MOVES*
Tony Ciavarelli, Mike McCauley
- 0850-0910 *Motion Effects on Human Performance*
Mike McCauley

- 0910-0930 *Human Factors: An Overview of Course Content and Research*
Tony Ciavarelli
- 0930-0950 *Know Your Users: Reflections from Field Visits to MCAGCC, 29 Palms*
Amela Sadagic
- 0850-0910 *Training and Simulation: The VIRTE Program*
Bill Becker
- 1000-1030 Break
- 1030-1130 *Panel Discussion: Open Source and Open Standards in Defense M&S*
Don Brutzman, Rudy Darken, Perry McDowell, Sean Harrigan
- 1130-1150 *Advanced XMSF Initiatives featuring: XML Tactical Chat (XTC), Coalition Secure Management and Operations System (COSMOS), Battlespace Markup Language (BML)*
Capt Adrian Arnold, USMC, Don Brutzman, Curt Blais
- 1150-1200 Closing Comments
1200 Adjourn
- 1200-1400 Advisory Board Meeting (Lunch)

FREQUENTLY ASKED QUESTIONS

HOW DOES AN ASW CERTIFICATE HELP ME?

Completion of the ASW Certificate program provides you with a practical skill set that can be employed immediately in your professional career.

Credit from courses completed through the ASW Certificate Program can be applied toward a masters degree in the USW program. In most cases, students qualify for one quarter of credit toward a masters degree.

WHAT ARE THE PREREQUISITES?

Students pursuing the ASW certificate need a working knowledge of single-variable calculus, probability and MATLAB.

Prerequisite courses may be available as distance-learning courses through the NPS Office of Continuous Learning. Prerequisite courses include:

- MA1113 - Single Variable Calculus
- OS2100 - Probability and Statistics
- OC2020 - MATLAB Programming

IS THERE A SERVICE COMMITMENT?

There is no service commitment associated with the ASW certificate program.

WHAT WILL IT COST ME?

Students will be expected to purchase relevant textbooks and incidental supplies.

WHO IS ELIGIBLE?

Naval officers (Active Duty or Reserve), government laboratory engineers, Navy civilians (afloat and ashore staff), and Navy enlisted with an ASW background are all eligible to enroll in the ASW certificate program.

FOR MORE INFORMATION OR TO APPLY PLEASE CONTACT:

ASW-CERTIFICATE@NPS.EDU

CDR John Joseph, USN
Program Officer
Undersea Warfare Program
(831) 656-2044
DSN 756-2044
jejoseph@nps.edu

Dr. Don Brutzman
Chair, USW Academic Committee
(831) 656-2149
brutzman@nps.edu

Roger F. Bacon, Vice Admiral, USN (ret.)
Chair, Professor of Undersea Warfare
(831) 656-2488
DSN 756-2488

Tom Hazard
Director
NPS Office of Continuous Learning
(831) 656-3580
DSN 756-3580



[HTTP://WWW.NPS.EDU/DL/NPSO](http://www.nps.edu/dl/npsoc)

Office of Continuous Learning
411 Dyer Road, Knox 102
Monterey, CA 93943, USA

May 2004

ASW CERTIFICATE IN ANTI-SUBMARINE WARFARE



"ASW is Job One in
the Pacific theatre."

Admiral Walter F. Doran
United States Navy
Commander,
U.S. Pacific Fleet



Naval Postgraduate School

THE ASW CERTIFICATE PROGRAM

The curriculum for the Anti-Submarine Warfare (ASW) Certificate Program supports the needs of the Navy in ASW, and complements existing warfare ASW training and qualification.

The ASW Certificate Program provides a science and engineering foundation which covers fundamental concepts in four areas:



These subjects are the educational cornerstone for this highly interdisciplinary certificate program.

"ASW is a team sport: aviation, surface warfare, and submarines."

*RADM Paul F. Sullivan, USN
COMSUBPAC*



THE ASW CERTIFICATE CURRICULUM

Anti-Submarine Warfare encompasses multiple disciplines. The ASW Certificate is a distance learning curriculum that consists of four fully accredited courses delivered by multiple modes of instruction. Offered over a one-year period, these courses develop critical analytic skills and understanding of fundamental principles applied in ASW.

"ASW is a Navy-unique core competency which we must further develop to ensure our undersea supremacy."

*RADM John J. Waickwicz, USN
Commander, Fleet Anti-Submarine Warfare Command*

PH2401 — INTRODUCTION TO SONAR EQUATIONS

A discussion of each term of the sonar equations, with application to the detection, localization, and classification of underwater targets.
(No prerequisites)

OA3602 — SEARCH THEORY & DETECTION

Search and detection as stochastic processes.
(Prerequisite: probability)

EC2450 — REVIEW OF SIGNALS AND SYSTEMS

Fundamentals of discrete-time and continuous-time signals and systems. (Prerequisites: single-variable calculus, basic MATLAB programming skills)

OC2930 — INTRODUCTION TO OCEANOGRAPHY FOR UNDERSEA WARFARE

An introduction to ocean processes and phenomena with applications to Undersea

THE USW CURRICULUM AT NPS

Students with an ASW Certificate are well positioned to continue their education and professional development by pursuing a masters degree through the Undersea Warfare (USW) curriculum at the Naval Postgraduate School (NPS). This highly interdisciplinary program focuses on engineering fundamentals, physical principles, operations research, and systems analysis that contribute to USW, ASW and Mine Warfare (MIW) operational employment.

Students can choose from one of five accredited disciplines:

- Operations Research
- Physical Oceanography
- Electrical Engineering
- Engineering Acoustics
- Applied Science



"A robust and integrated Anti-Submarine Warfare architecture, more capable force structure and a committed investment in future technologies are essential to counter the growing submarine threat."

*ADM Thomas B Fargo, USN
Commander, U.S. Pacific Command*

For a more in-depth description of these certificate courses please visit:
<http://www.nps.navy.mil/ofcinst/courses.htm>

For information regarding masters degrees in the NPS USW curriculum, please visit:
<http://www.nps.navy.mil/usw>

UNDERSEA WARFARE RESEARCH OPPORTUNITIES

- *Operational Oceanography*
- *Shallow Water Signal Processing*
- *Marine Mammal Bio Acoustics*
- *Acoustic Mine Detection*
- *Tactical Decision Making Under Uncertainty*
- *Underwater Surveillance*
- *Fluid Dynamics of Underwater Weapons*
- *Low Frequency Array Modeling*
- *Mine Countermeasures, Mine Warfare*
- *Digital Signal Processing*
- *Autonomous Ocean Robotics*

"The versatile nature of this program has allowed me to pursue a course of study tailored to my own interests with relevance to both my professional military career and the challenges that lie beyond."

*LT Robert Hill, USN
USW Student, September '03
Graduate*

The Naval Postgraduate School is located in the beautiful Monterey area. This is a great place to live!



There are many good schools; military housing is available, and recreational activities are limitless.

CONTACT INFORMATION

CDR John Joseph USN
Program Officer
(831) 656-2044
DSN 756-2044
jejoseph@nps.edu

Associate Professor Don Brutzman
Chair, Undersea Warfare
Academic Committee
(831) 656-2149
brutzman@nps.edu

Roger F. Bacon VADM USN (Ret.)
Chair Professor of Undersea Warfare;
Director, Undersea Warfare
Research Center
(831) 656-2488
rfbacon@nps.edu

John D. Pearson RADM USN (Ret.)
Chair Professor of Mine Warfare
(831) 656-7702
jdpearso@nps.edu



www.nps.navy.mil/usw

Naval Postgraduate School
833 Dyer Rd., Spanagel 304
Monterey, CA 93943
Phone: (831) 656-2044

U S W

UNDERSEA WARFARE



MASTER OF SCIENCE DEGREE CURRICULA

*Educating officers in the core
scientific concepts that govern
Undersea Warfare*



NAVAL POSTGRADUATE SCHOOL

THE USW PROGRAM

THE PROGRAM

The Undersea Warfare (USW) curriculum focus is engineering fundamentals, physical principles, operations research and systems analysis that contributes to USW (antisubmarine and mine warfare (ASW/MIW)) operational employment. The program is interdisciplinary with specialization in:

Engineering Acoustics
(underwater acoustics and weapons effects)

Physical Oceanography
(emphasis on factors affecting acoustic surveillance and detection)

Operations Research
(emphasis on tactical applications and decision analysis)

Electrical Engineering
(emphasis on signal processing)

Applied Science
(with majors in oceanography, operations research, signal processing, and acoustics)



MASTERS DEGREES IN THE USW PROGRAM

THE MASTERS DEGREE

Master Degrees in the USW program require eight quarters (2 years) of academic challenges, including thesis research with direct application to current problems of interest to the Navy and the Department of Defense. Some one-year Immediate Graduate Education Program (IGEP) billets are available.

Your Master of Science Degree can be in one of the following accredited degree programs:

- Engineering Acoustics
- Physical Oceanography
- Operations Research
- Electrical Engineering (signal processing)
- Applied Science

PREREQUISITES

A baccalaureate degree or equivalent from a program with a calculus sequence and a calculus-based physics sequence that results in an Academic Profile Code (APC) of 323 is required for direct input.

GRADUATION

Upon graduation you will be equipped with strong technical and engineering skills to succeed in your profession. Your degree will further develop your ability to apply sound thinking and analytical reasoning when you are called upon to solve problems and make decisions.

"Tomorrow's force requires experts across the full spectrum of Naval operations, from warfare areas such as undersea warfare, to various engineering and technology curricula."

VADM Donald and RADM Sullivan
(COMNAVSUBFOR 291209Z July 04)

FREQUENTLY ASKED QUESTIONS

CAN I COMPLETE JOINT PROFESSIONAL MILITARY EDUCATION (JPME) PHASE I WHILE AT NPS?

Yes. JPME is integrated into the USW program. Naval War College faculty are on-site to allow for completion of the four required courses,

- Strategy and Policy
- National Security Decision Making
- Joint Maritime Operations Part 1
- Joint Maritime Operations Part 2

WHEN CAN I START?

Entry dates are in spring and fall (April and October).

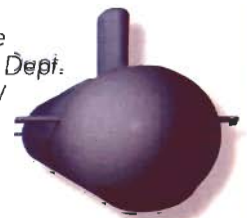
WHAT CAN I DO TO BE PREPARED?

A newly implemented ASW Certificate program allows early preparation for the USW program at NPS. The ASW Certificate is delivered via distance learning. For more information about the ASW Certificate Program, go to:

<http://www.nps.navy.mil/usw>

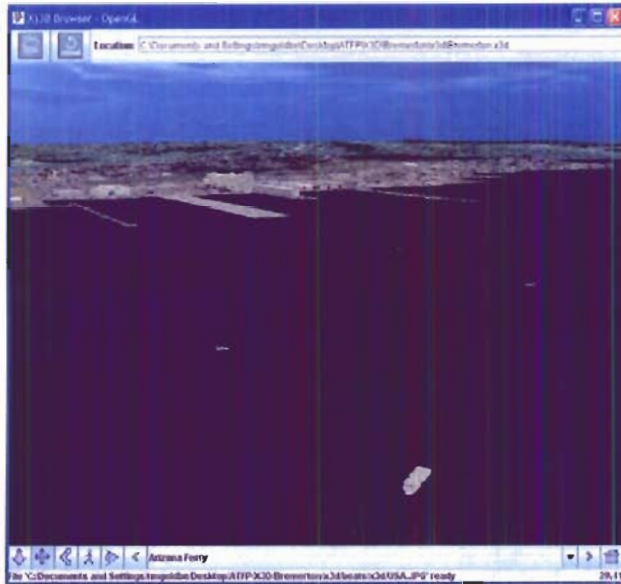
"...I believe that to successfully conduct USW operations requires a fundamental knowledge of four basic disciplines: oceanography, (characterize the ocean environment), physics (underwater acoustics), operations research (search and detection theory), and electrical engineering (signal processing)."

Professor Emeritus Bob Bourke
Former Chair, Oceanography Dept.
Founding Member, ASW/USW
Academic Group at NPS



Waterside Security (WSS) Anti-Terrorism / Force Protection (AT/FP) Project

How can we plan for the defense of our nation's harbors and waterways in a way that shows us surprise scenarios that we never imagined? How do we graphically visualize our best effort force protection plans? How do we show statistical data to support our findings of that best effort force protection plan for Naval forces abroad? How do we use Java to model opponents, render entire harbors using interactive 3D graphics, and even exercise clusters to provide high-confidence analytic results? **This project shows how.**



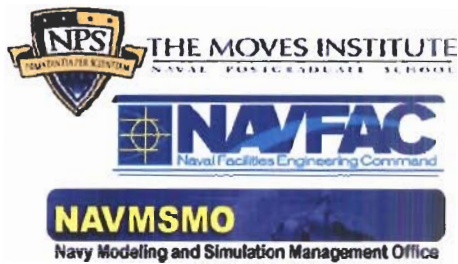
The waterside security project is a group effort. A top-notch team of industry, government and academic experts is using Java to produce a tactical application for use in defending national harbors and waterways. Scenarios can be autogenerated, viewed, analyzed, and manipulated by end users. Individual scenarios can be replayed from any vantage point using agent-driven X3D graphics models. Cluster-based computational assets use the Sun Grid Engine for heavy-duty replication of simulation scenarios, producing measures of effectiveness within statistically significant, analyst-specified confidence intervals.

Key technical features include:

- End-to-end Java application using Extensible Markup Language (XML) for all datasets
- ISO-Standard Extensible 3D Graphics (X3D) for military model archives
- Xj3D open-source browser and Java for OpenGL (JOGL) rendering speed
- Adding web-services queries for environmental and oceanographic dataset updates
- Runs out-of-the-box on Windows, Linux, Mac OS X, Solaris SPARC, Solaris x86 operating systems with NO recoding required to achieve consistent operation throughout



In order to model realistic tactics for friendly forces and opponents, the waterside security project uses Viskit and Simkit, open-source Java 2TM packages built for visual creation of Discrete Event Simulation (DES) models. Simkit is used at NPS to teach advanced simulation concepts and demonstrate analytically meaningful real-world results. The labs and tutorials are available online, downloadable at <http://diana.g1.nps.navy.mil/Simkit>.

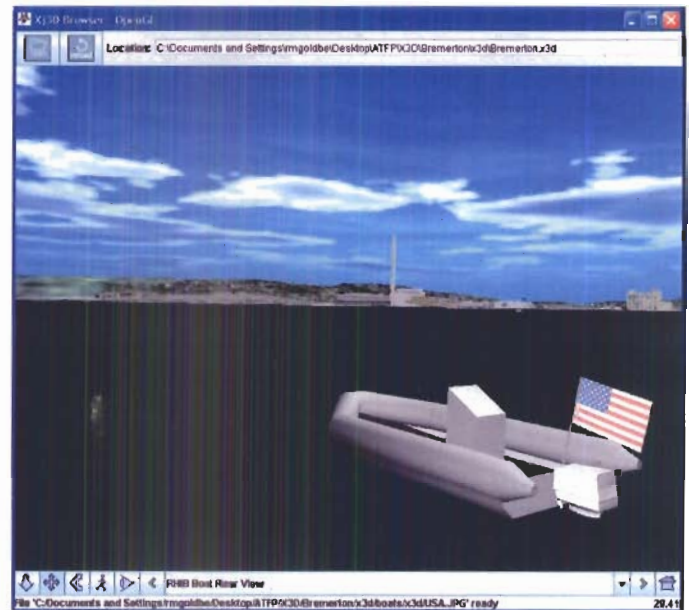


The production team putting all this work together includes the following partners:

- NPS MOVES Institute, Dr. Don Brutzman, <http://www.movesinstitute.org>
MOVES is currently nominated as a Sun Center-of-Excellence (COE) in Modeling and Simulation
- Aniviza, Inc., Rick Goldberg, CEO, <http://www.aniviza.com>
- Planet 9 Studios, David Colleen, CEO, <http://www.planet9.com>
- Yumetech, Inc., Alan Hudson, CEO, <http://www.yumetech.com>

Sponsors include:

- Naval Facilities Engineering Service Center (NFESC), <https://portal.navfac.navy.mil>
- Navy Modeling & Simulation Office (NMSO), <http://navmsmo.hq.navy.mil>
- Web3D Consortium, <http://www.web3D.org>



Network connectivity is provided among multiple users via standards-based implementation of the IEEE Distributed Interactive Simulation (DIS) behavior protocol. This waterside security project will soon undergo initial user testing using naval officers at NPS, and then be tested using actual waterfront facilities. It is likely to provide significant improvements in the situational awareness and defensive posture of ships defending against terrorist attacks in port. The demonstrated scenario features security forces defending against hostile entities in a simulated attack on Bremerton Washington harbor.

Inquiries are welcome. For further info, contact Don Brutzman (brutzman@nps.navy.mil), 1.831.656.2149.

FREQUENTLY ASKED QUESTIONS

HOW DOES AN ASW CERTIFICATE HELP ME?
Completion of the ASW Certificate program provides you with a practical skill set that can be employed immediately in your professional career.

Credit from courses completed through the ASW Certificate Program can be applied toward a masters degree in the USW program. In most cases, students qualify for one quarter of credit toward a masters degree.

WHAT ARE THE PREREQUISITES?

Students pursuing the ASW certificate need a working knowledge of single-variable calculus, probability and MATLAB.

Prerequisite courses may be available as distance-learning courses through the NPS Office of Continuous Learning. Prerequisite courses include:

- MA1113 - Single Variable Calculus
- OS2100 - Probability and Statistics
- OC2020 - MATLAB Programming

IS THERE A SERVICE COMMITMENT?

There is no service commitment associated with the ASW certificate program.

WHAT WILL IT COST ME?

Students will be expected to purchase relevant textbooks and incidental supplies.

WHO IS ELIGIBLE?

Naval officers (Active Duty or Reserve), government laboratory engineers, Navy civilians (offlot and ashore staff), and Navy enlisted with an ASW background are all eligible to enroll in the ASW certificate program.

FOR MORE INFORMATION

OR TO APPLY

PLEASE CONTACT:

ASW-CERTIFICATE@NPS.EDU

CDR John Joseph, USN
Program Officer
Undersea Warfare Program
(831) 656-2044
DSN 756-2044
jjoseph@nps.edu

Dr. Don Brutzman
Chair, USW Academic Committee
(831) 656-2149
brutzman@nps.edu

Roger F. Bacon, Vice Admiral, USN (ret.)
Chair, Professor of Undersea Warfare
(831) 656-2488
DSN 756-2488

Tom Hazard
Director
NPS Office of Continuous Learning
(831) 656-3580
DSN 756-3580



[HTTP://WWW.NPS.EDU/DL/NPSO](http://www.nps.edu/DL/NPSO)

Office of Continuous Learning
411 Dyer Road, Knox 102
Monterey, CA 93943, USA

May 2004

ASW CERTIFICATE IN ANTI-SUBMARINE WARFARE



"ASW is Job One in the Pacific theatre."

Admiral Walter F. Doran
United States Navy
Commander,
U.S. Pacific Fleet



Naval Postgraduate School



THE ASW CERTIFICATE PROGRAM

The curriculum for the Anti-Submarine Warfare (ASW) Certificate Program supports the needs of the Navy in ASW, and complements existing warfare ASW training and qualification.

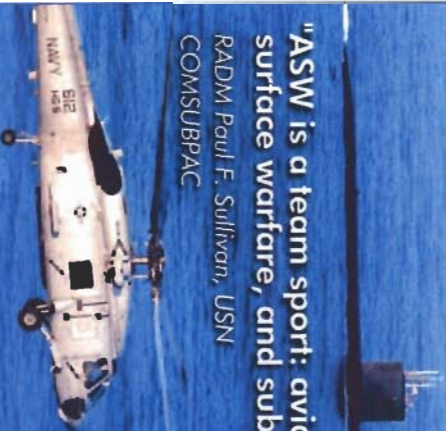
The ASW Certificate Program provides a science and engineering foundation which covers fundamental concepts in four areas:

PHYSICAL OCEANOGRAPHY
SIGNAL PROCESSING
ASW
OPERATIONS RESEARCH
ENGINEERING ACOUSTICS

These subjects are the educational cornerstone for this highly interdisciplinary certificate program.

"ASW is a team sport: aviation, surface warfare, and submarines."

*RADM Paul F. Sullivan, USN
COMSUBPAC*



THE ASW CERTIFICATE CURRICULUM

Anti-Submarine Warfare encompasses multiple disciplines. The ASW Certificate is a distance learning curriculum that consists of four fully accredited courses delivered by multiple modes of instruction. Offered over a one-year period, these courses develop critical analytic skills and understanding of fundamental principles applied in ASW.

"ASW is a Navy-unique core competency which we must further develop to ensure our undersea supremacy."

*RADM John J. Waickwitz, USN
Commander, Fleet Anti-Submarine
Warfare Command*

PH2401 — INTRODUCTION TO SONAR EQUATIONS

A discussion of each term of the sonar equations, with application to the detection, localization, and classification of underwater targets. (No prerequisites)

OA3602 — SEARCH THEORY & DETECTION

Search and detection as stochastic processes. (Prerequisite: probability)

EC2450 — REVIEW OF SIGNALS AND SYSTEMS

Fundamentals of discrete-time and continuous-time signals and systems. (Prerequisites: single-variable calculus, basic MATLAB programming skills)

OC2930 — INTRODUCTION TO OCEANOGRAPHY FOR UNDERSEA WARFARE

An introduction to ocean processes and phenomena with applications to Undersea

THE USW CURRICULUM AT NPS

Students with an ASW Certificate are well positioned to continue their education and professional development by pursuing a masters degree through the Undersea Warfare (USW) curriculum at the Naval Postgraduate School (NPS). This highly interdisciplinary program focuses on engineering fundamentals, physical principles, operations research, and systems analysis that contribute to USW, ASW and Mine Warfare (MIW) operational employment.

Students can choose from one of five accredited disciplines:

- Operations Research
- Physical Oceanography
- Electrical Engineering
- Engineering Acoustics
- Applied Science



"A robust and integrated Anti-Submarine Warfare architecture, more capable force structure and a committed investment in future technologies are essential to counter the growing submarine threat."

*ADM Thomas B. Fargo, USN
Commander, U.S. Pacific Command*

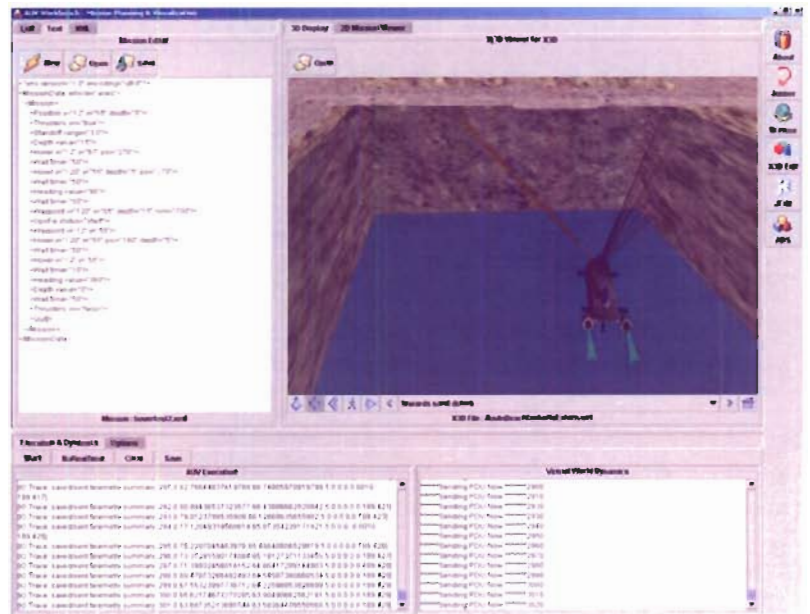
For a more in-depth description of these certificate courses please visit:
<http://www.nps.navy.mil/ofcinst/courses.htm>

For information regarding masters degrees in the NPS USW curriculum, please visit:
<http://www.nps.navy.mil/usw>

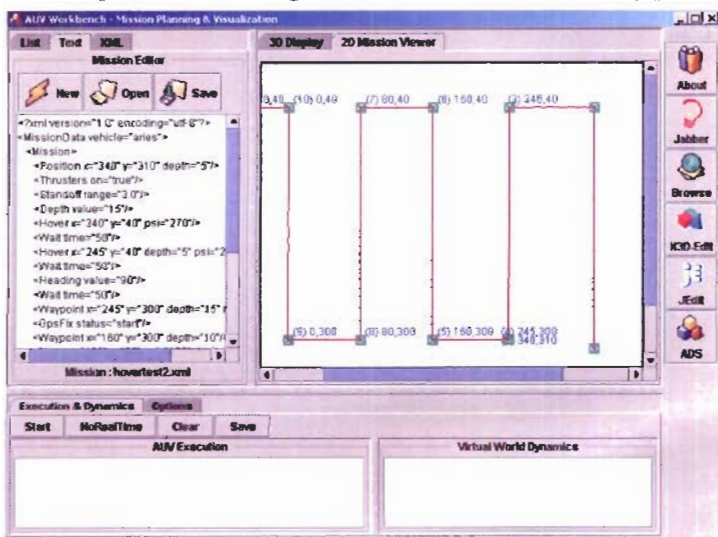
NPS Autonomous Underwater Vehicle (AUV) Workbench

1. The NPS AUV Workbench supports physics-based AUV modeling and visualization of vehicle behavior and sensors in all mission phases.

- Animation based on vehicle-specific hydrodynamics that can be configured to model arbitrary vehicles.
- Models defined in X3D and VRML relying on Distributed Interactive Simulation Protocol allow visualization across networks utilizing custom software or off-the-shelf web browsers.
- Virtual environment facilitates control algorithm development, control constant testing, mission generation and rehearsal, and replay of completed missions in a benign laboratory environment.



2. Graphical mission generation and data handling provides:



- Automated generation of mission specifications in an XML-based command language supports mission scripting, vehicle-to-vehicle, vehicle-to-agent, & vehicle-to-human communications, as well as storage of runtime telemetry data.
- Automated conversion of XML mission into various arbitrary text-based AUV command languages using XSLT transformation.
- Efficient serialization and transmission of generated imagery, telemetry and reports using XML Schema Binary Compression (XSBC).
- Integrated sonar visualization capabilities.

3. XML-based Tactical Chat (XTC) provides open-source communications protocol among remote vehicles and individual operators, either in the virtual or real worlds.

- Reliable asynchronous data transfer between AUVs, other vehicles, agents and human controllers.
- Automatic logging of all communications in a schema-constrained XML format that facilitates data retrieval for post-mission-analysis and mission reconstruction.

4. AUV Workbench autoinstaller publicly available at <http://terra.cs.nps.navy.mil/AUV/workbench> with poster online at <http://www.movesinstitute.org/xmsf/projects/AUV/AUVWorkbench.jpg>

5. For more information, please contact CDR Duane Davis, USN (dtdavis@nps.navy.mil) or Dr. Don Brutzman (brutzman@nps.navy.mil) at the Naval Postgraduate School, Modeling and Virtual Environments (MOVES) Institute and NPS Center for AUV Research, Monterey California. Project links online at <http://www.movesinstitute.org/xmsf/xmsf.html#Projects-AUV>

A D V A N C E D IMAGING

Simulated Terrorist Attacks: Virtually Risk-Free

The Anti-Terrorism Force Protection Program allows the military to rehearse defensive tactics from a first-person point-of-view.

An image from the Non-combatant Evacuation Operation (NEO) Scenario, similar to an operation that occurred in Port-au-Prince, Haiti, when U.S. Marines were sent in to secure the U.S. Embassy and evacuate non-essential personnel. The old Del Monte Hotel, now called Hermann Hall, is visible—complete with interior spaces and fully textured. The original building model was constructed by John Locke of the MOVES Institute and translated into X3D by Captain Claude "Oodge" Hutton, USMC and Jeff Weekley. This image was generated and processed using the Cortana plug-in (for Internet Explorer) and Adobe Photoshop.



by Leonard A. Hindus

The guided missile destroyer was visiting a foreign port. The captain, a highly decorated, battle-hardened veteran, scrupulously followed Navy regulations, setting up a defensive perimeter of crewmen in motorized launches that patrolled the area 24 hours a day.

Without warning, a sleek speedboat raced toward the Naval vessel. The launches moved to intercept but were no match for the smaller craft, which was loaded with explosives. It zipped past the defenders and rammed the destroyer.

Had this been an actual attack, it would have cost the lives of American crewmen and inflicted millions of dollars in damage to the ship.

In simulation, however, such disasters can be reversed—a luxury not afforded to ship commanders in the field. Through repeated rehearsals, a captain can adjust his defensive

strategy and intercept virtual attackers before they reach their targets.

The Anti-Terrorism Force Protection Program is a 3D simulation project developed by Dr. Don Brutzman and the SAVAGE Group (Scenario Authoring and Visualization for Advanced Graphical Environments) at the MOVES Institute (Modeling, Virtual Environments and Simulation), located at the Naval Postgraduate School in Monterey, CA. In this X3D, XML and Agent-based simulation—named “the U.S.S. Cole Scenario” after a Navy ship that was attacked and damaged in the manner described above—users can rehearse various terrorist attacks from a first-person point-of-view.

“You can realistically assess defensive tactics and see what would or would not protect the ship from attack,” Brutzman told *Advanced Imaging*. “You can replay dangerous ‘what-if’ scenarios and the risks are only virtual.”

VIRTUAL WORLDS FOR SMART SUBMARINES

“We started creating virtual environments because that was the only way to test-program autonomous underwater vehicles (AUVs)” Brutzman explained. “Once an AUV is launched, it’s on its own. If there is a flaw in the programming, there’s no predicting what it might do. It is tremendously difficult to observe, communicate with and test underwater robots, because they operate in a remote and hazardous environment.”

To that end, Brutzman’s team needed to create a realistic underwater virtual world that might comprehensively model all salient functional characteristics of the real world, and in real-time. This virtual world was designed from the perspective of the robot, enabling realistic AUV evaluation and testing in the laboratory. “Robots don’t need imaging to navigate; people need imaging to under-



An Anti-Terrorism Force Protection Agent simulation, based on an aerial image of Pearl Harbor. The buildings, X3D models geo-rectified with the aerial imagery, appear in the simulation as they actually do at the boat basin. All models were built and integrated into the virtual world by Lt. James Harney, USN. This image was generated and processed by Jeff Weekley using the X3D Open Source Browser and Adobe Photoshop.

stand the robot's logic," said Jeff Weekley, a senior designer with the MOVES Institute. "3D real-time graphics are our window into the virtual world."

Visualization of robot interactions within a virtual world allows for sophisticated analyses of robot performance that are otherwise unavailable. Sonar visualization permits researchers to look over the robot's shoulder or even see through its eyes to understand sensor-environment interactions intuitively.

Despite the virtual trappings, this is serious business, as demonstrated in *AI's* March 2003 issue ("Modeling & Simulation: Hollywood Fulfills Military Needs," Rich Handley, p. 10). "This is not a video game," Brutzman stressed, "but a real-world simulation. It not only has to look real... it has to be real." He added, "We need to model the real world in as much detail as possible." This is vital, as the Navy wants to be sure the AUVs tested in simulation at the MOVES Institute will behave the same way in the open ocean.

NPS AUTONOMOUS UNDERWATER VEHICLE (AUV) WORKBENCH

As a result of this research, the NPS Autonomous Underwater Vehicle (AUV) Workbench is now publicly available. A flyer, poster and self-installer can be found at <http://terra.cs.nps.navy.mil/AUV/workbench>.

The flyer states, "The NPS AUV Workbench supports physics-based AUV modeling and visualization of vehicle behavior and sensors in all mission phases. Animation is based on vehicle-specific hydrodynamics that can be configured to model arbitrary vehicles. Models defined in X3D and VRML, relying on IEEE Distributed Interactive Simulation Protocol (DIS) allow visualization across networks utilizing custom software or off-the-shelf Web browsers. Virtual environments facilitate control algorithm development, constant testing, mission generation and rehearsal, and replay of completed missions in a benign laboratory environment."

BUILDING A VIRTUAL WORLD VIEWER

The benefits don't stop there, though. "Once you develop tools for creating virtual environments," Brutzman said, "the applications are almost limitless." A good graphics toolkit for building a virtual world viewer has many requirements to fill. Rendered scenes need to be realistic and rapidly rendered, permitting user interaction. The tools need to

be capable of running on both low-end and high-end workstations. Graphics programmers must have a wide range of tools to permit interactive experimentation and scientific visualization of real-world datasets.

The ability to read multiple data formats is also important when using scientific and oceanographic datasets. Scientific data format compatibility can be provided by a number of data function libraries that are open, portable, reasonably standardized and usually independent of graphics tools. Viewer programs need to be capable of examining high-bandwidth information streams and large archived scientific databases. The ability to pre-process massive datasets into useful, storable, retrievable graphics objects will be particularly important as we attempt to scale up to meet the sophistication and detail of the real world. Standardization of computer graphics and portability across other platforms, Brutzman pointed out, are also desirable but historically elusive. X3D solves this.

Simulation software should be able to take advantage of the Internet and run virtual environments remotely, according to Brutzman. "History has taught us that virtual worlds often outlast the proprietary hardware and software they were designed on." To achieve these goals, the MOVES Institute has been involved in the development of several open standards. These include XMSF and X3D.

XMSF

The Extensible Modeling and Simulation Framework (XMSF) is defined as a set of Web-based technologies, applied within an extensible framework, enabling a new generation of modeling and simulation

(M&S) applications to emerge, develop and interoperate. Specific subject areas for XMSF include (a) Web/XML, (b) Internet/networking and (c) modeling and simulation (M&S). XMSF information can be found at www.movesinstitute.org/xmsf/xmsf.html. XMSF-based Web services are sufficiently powerful for all types of modeling and simulation.

X3D

Extensible 3D (X3D) is the ISO-approved next-generation open standard for 3D on the Web. It is an extensible standard that can easily be supported by content-creation tools, proprietary browsers and other 3D applications, both for importing and exporting. X3D not only replaces VRML, but also provides compatibility with existing VRML content and browsers. Existing VRML content will be played without modification in any X3D browser, and new X3D content can be read in to existing VRML applications.

X3D addresses the limitations of VRML. It is fully specified, so content will be fully compatible. It is also extensible, which means that X3D can be used to make a small, efficient 3D animation player, or to support the latest streaming or rendering extensions. It supports multiple encodings and APIs, so it can easily be integrated with Web browsers through XML or with other applications. In addition to close ties with XML, X3D is the technology behind MPEG-4's 3D support. X3D information can be found at www.web3d.org.

Don Brutzman is right. With the proper tools for creating virtual environments, the applications truly are nearly limitless. ♦

Leonard A. Hindus is a long-time contributing editor for Advanced Imaging magazine. He can be reached by phone at (978) 568-0495, or via e-mail at hindus@ribbledale.com.

Reprinted with permission from Advanced Imaging, March 2004.

Port Perils

The President of the United States has just ordered a Navy task force to San Luis Rey, the principal port of the island of Monterey, at the request of their government, to help protect their nuclear power plant. Until a recent change in government, Monterey had been strongly anti-American. As a result, no one currently in the Navy has ever sailed into this port. To make matters worse, this is a particularly tricky port with rocks and reefs and strong cross-currents.

During approach, forward-looking SONAR reveals an uncharted rock. At the same time, a terrorist with a rocket-propelled grenade launcher is spotted on a nearby hill. What can the captain do to save his ship? "Let's send in the robots first next time," someone suggests as they change the parameters of the Virtual Port program for the next run.

The Virtual Port is a 3D computer simulation proposed by Don Brutzman, PhD., an associate professor at the Naval Postgraduate School (Monterey, CA). The captain and crew are stationed in a full-scale bridge mock-up in an immersive 3D virtual environment. They can sail into port day or night and under all possible weather conditions. In addition to old bridges and such natural hazards as reefs and rocks, they can face attacks from shore-fired rockets and high-speed boats loaded with explosives. By the time the task force is ready to sail, the captains and their crews might know the port like they had been sailing there for years.

"We have all the tools we need to create a virtual tactical immersive environment for any port in the world," Brutzman told *AI*. "All we need is funding and a year or two to integrate the data and create the environments. Our NPS team foresees a day when Navy crews can call upon a library of virtual ports to practice deployment anywhere in the world." ♦



Extensible Modeling and Simulation Framework (XMSF) Demonstrations

Naval Postgraduate School (NPS)

MOVES Institute (Modeling, Virtual Environments and Simulation)

Interservice/Industry Training, Simulation and Education Conference (I/ITSEC)

Booth #2249

featuring XMSF partners and contributors:

George Mason University, Aniviza, Yumetech, Media Machines,
Distance Learning Resource Center and the Web3D Consortium



You are cordially invited to visit the NPS and MOVES Institute XMSF booth (#2249) on the I/ITSEC show floor in Orlando, Florida, December 6-9 2004. Students, faculty, and partners are presenting numerous project demonstrations. Our use of open standards and web services illustrates the capabilities of the new web-enabled modeling & simulation initiative called the Extensible Modeling & Simulation Framework (XMSF).

<http://www.MovesInstitute.org/xmsf>

XMSF efforts are producing a composable set of standards, profiles and recommended practices for web-based modeling and simulation (M&S). Open standards, XML-based markup languages, internet technologies and cross-platform, cross-system web services are enabling a new generation of distributed M&S applications to emerge, develop, and interoperate. Working groups in the Simulation Interoperability Standards Organization and Web3D Consortium are laying a strong foundation for future growth.

Partners in XMSF efforts are located at the Defense Modeling and Simulation Office (DMSO) booth (#530), ODU/VMASC booth (#2418), and SAIC booth (#2605). DMSO has declared that the Web services approach is a key **technology strategy** for revolutionizing military modeling and simulation and for **connecting** to tactical command and control systems.

Thanks to DMSO, NAVMSMO, Delta3D, and DLRC for their co-sponsorship of the XMSF booth during this conference.

Thanks to the following project sponsors: DMSO, Joint Advanced Distributed Learning Co-Laboratory (JADL Co-Lab), Naval Air Systems Command (NAVAIR), Defense Threat Reduction Agency (DTRA), USAF Joint Synthetic Battlespace (JSB), Joint Forces Command (JFCOM) J9, OPNAV Assessment Division (N81), Naval Undersea Warfare Center (NUWC), U.S. Army Engineer Research and Development Center (ERDC), U.S. Army TRADOC Analysis Center Monterey (TRAC-Monterey), Sonalysts, Inc. and Web3D Consortium.



We are showing the following demonstrations and presentations in the XMSF booth.
Demonstration appointments are available upon request:

xmsf-contact@movesinstitute.org

Extensible Modeling and Simulation Framework (XMSF)

Dr. Don Brutzman, NPS MOVES Institute

Extensible Battlespace Management Language (XBML) and XMSF Overlay Multicast (XOM)

Dr. J. Mark Pullen, George Mason University (GMU)

Xj3D: Open Source Implementation of the X3D Graphics Language

Alan Hudson and Justin Couch, Yumetech, Inc.

Online Mentors for Language Training and Cultural Familiarization

Jeffrey Weekley, MOVES Institute Research Associate and Computer Science Masters student
Dr. Ed Sims, Chief Technology Officer, Vcom3D, Inc. and Dr. Luba Grant, Defense Language Institute (DLI)

Scenario Authoring and Visualization for Advanced Graphical Environments (SAVAGE)

On-Line Library of X3D Military Models and Authoring Tools
Jeffrey Weekley, NPS

Anti-Terrorism / Force Protection (AT/FP) Planning Tool

Jeffrey Weekley

Semantic Interoperability: Data Mapping and Ontology Development

Curtis Blais, NPS MOVES Institute Research Associate and MOVES Ph.D. student

Combat Model Interoperability using Web Services and Discrete Event Simulation (DES) Simkit Library

N81-sponsored Project to Transform Analytical Modeling
John Ruck and Ed Bryla, Rolands & Associates Corporation

Visual Simulation Toolkit (Viskit): Graphical User Interface for Rapid Simulation Development

Rick Goldberg, Aniviza

Autonomous Underwater Vehicle (AUV) Workbench

CDR Duane Davis, USN, NPS Computer Science Ph.D. student

Sonar Visualization for Multi-Platform Net-Centric Undersea Warfare

CDR Duane Davis

NPS Interactive Web-Based Media Elements

Web-based exercises and animations for NPS online course modules
Kari Miglaw, OCL NPS, Dale Courtney, NPS, Ann Igoc, DLRC (OCL NPS),
Djanna Beardslee, DLRC (OCL NPS)

Flux: Reusable Modeling & Simulation Components Based on Open Standards

Tony Parisi, President, Media Machines

Partners:

Navy Modeling and Simulation Management Office (NAVMSMO)

Vcom3D (#243)

Planet 9 Studios (#1122)