Issue 57 November 2015

# CRUSER · NEWS

Consortium for Robotics and Unmanned Systems Education and Research

## From Technical to Ethical...From Concept Generation to Experimentation

### Contents



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## The Future of Just War: Theoretical and Practical Challenges

by Dr Bradley Strawser, NPS Faculty, bjstraws@nps.edu

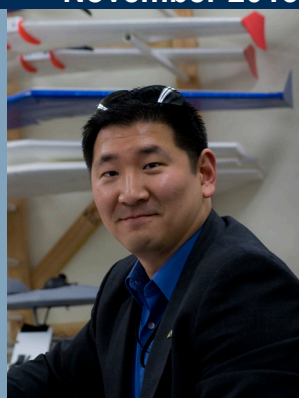
Over the course of three days in early October, NPS hosted a large international conference entitled The Future of Just War: Theoretical and Practical Challenges. Organized and led by Defense Analysis Assistant Professor Bradley J. Strawser, the conference was truly a smashing success. Nearly 40 peer-reviewed papers were presented, along with four keynote addresses, from scholars representing eight different countries. The work presented ranged across a wide-gamut of important CRUSER-related areas of research, including papers on autonomous machines, emerging cyberwar technology, drone proliferation, robotics development, and related areas, and the many ways in which all of these novel forms of warfare present new and future challenges to our understanding of just war theory. The ethics of war is currently a hot and important subfield in philosophy, political science, and law, as was clear from the many participants involved in the conference from all of these disciplines. Indeed, there was a broad and diverse range of disciplines represented, with scholars from computer scientists to English professors present. Several NPS professors gave papers and attended as well, as did several NPS students. One such student, LT Forrest Crowell from the Defense Analysis Department, gave one of the peer-reviewed papers when he presented a version of his forthcoming thesis. Forrest's work explores the vexing ethical and professional questions raised by the recent rise in the commodification and market branding of the SEALs. His talk was one of the most highly attended and well received of the entire conference.

This kind of endeavor is a perfect example of how CRUSER can bring together its research and educational mission in one event. Important new research on the cutting edge of these fields was presented and disseminated, while NPS students simultaneously learned and developed while engaging the top minds in the world on these questions. Several NPS students were able to meet in person with scholars whose work they had been reading in their research while at NPS. And such an event, in turn, significantly helps to raise the international presence and influence of work being done at NPS around the globe. One of the keynote speakers, Dr. David Rodin, director of the Institute for Ethics, Law, and Armed Conflict at Oxford University, remarked at the conclusion of the conference, "This really was amazingly successful in both format and content and I hope that this format will be picked up again either with you again or elsewhere." He went on to comment that the conference opened his eyes to the important research being done at NPS along with our incredible and unique students and what they bring to the table.

Going forward, the conference participants are continuing their important networking and feedback on each other's work that began at the conference. The majority of papers presented will be revised and slated for publication in various research forums across the many disciplines represented. The entire CRUSER community should take pride in this remarkable academic achievement.

# Director's Corner

**Tim Chung CRUSER Deputy Director**



The breadth of the unmanned systems community highlights the diverse perspectives, ranging from ethical challenges facing autonomous machines and cyber warfare, to life-cycle considerations for cost and operations, to continued advances in multi-domain unmanned systems capabilities. As this community grows with greater operational relevance and impact, we've witnessed how continual exchange of information and ideas has enabled us to transition from responding to warfighter needs to inspiring them, as seen in many facets across DoD. CRUSER remains eager to help facilitate such collaborative interactions! Also, a special note of thanks to all of our veterans for your service!

## Multi-Domain Unmanned Systems Implementation Creates Comprehensive Maritime Situational Awareness

by Morgan Stritzinger, Public Relations Specialist, Textron Systems, mstritzi@textronsystems.com

The collaboration of unmanned aircraft systems (UAS), unmanned surface vehicles (USVs) and unmanned underwater vehicles (UUV) extends relative reach, and therefore the operational footprint. The unmanned aircraft and USV work together to extend data link ranges, and the USV can carry, deploy and recover the UUV, thereby extending its range and providing a safer environment for the host vessel. Extending mission capabilities is critical to efficient and effective maritime missions, creating situational awareness that delivers actionable data and value.

Unmanned systems are best suited for tasks too "dull, dirty or dangerous" for their manned counterparts and are a pertinent complimentary system to manned asset efforts. This includes repetitive tasks that are more costly for humans to perform or represent opportunity for human error, situations in extreme weather and environmental conditions, as well as the execution of dangerous tasks such as mine warfare or mine countermeasures, keeping humans out of harm's way. Unmanned systems allow humans to remain at a standoff distance, while monitoring and maintaining defense in areas of interest.

Today, unmanned systems can be leveraged in airborne, surface and underwater modalities to bring interoperable force multiplication to the fleet.

- UAS overhead deliver real-time full-motion video. Multi-mission Small UAS like Aerosonde™ system carry additional sensors, delivering communications relay and electronic warfare capacity, as well as intelligence, surveillance and reconnaissance – simultaneously.
- USVs offer flexible payload bays that can be equipped for mission sets from mine countermeasures to counter-piracy. The Common Unmanned Surface Vehicle (CUSV™) for the U.S. Navy's Unmanned Influence Sweep System (UISS) program is an example.
- The U.S. Navy intends to use the UISS as a mine countermeasure system, designed for sweeping of magnetic and acoustic mines. The CUSV will conduct this mission by towing an underwater sweep system. Small unmanned underwater vehicles, or UUVs, are emerging with various capabilities at different depths that can be easily deployed, towed and retrieved from the CUSV.

Together, these systems can provide the fleet with multi-domain situational awareness and extended reach and operational capability. Multi-platform control allows several systems to be controlled in parallel, collecting data from numerous sensors, enhancing the common operational picture, and allowing task synchronization. This data fusion at the source, rather than separate from the engagement in an intelligence cell, speeds the decision cycle.

Persistence is another critical advantage in implementing multiple unmanned systems in a maritime environment. Unmanned systems provide multi-sensor coverage over vast expanses with significant endurance.

Supplementing the fleet with unmanned systems also affords value advantages with more streamlined system footprints, logistical requirements and personnel demands.

Supporting this are interoperable command-and-control (C2) technologies, maintaining system and payload control of all unmanned systems simultaneously. Currently, Textron Systems' Universal Ground Control Station (UGCS) is the common control station for the Shadow®, Gray Eagle® and Hunter UAS. C2 systems can form the foundation for teaming between unmanned systems in the multi-domain scenario and can also do so for digital interoperability between manned systems such as the AH-64 Apache and unmanned systems like Shadow and Gray Eagle. Finally, common C2 streamlines training, logistics and maintenance needs and costs.

Unmanned systems technology has advanced to create a significant information and capability advantage for maritime operations. This multi-domain awareness allows personnel to synchronize tasks more seamlessly and turn data into decisive action.



## CRUSER Calendar

16 Nov (1200 PST) - Monthly Meeting
7 Dec (1200 PST) - Monthly Meeting
9-12 Feb 2016 - JIFX
details at http://CRUSER.nps.edu

# Unmanned Maritime Systems Operations and Maintenance Lifecycle Costs

by Dr Diana Angelis, NPS Faculty, diangeli@nps.edu

The Navy currently has a number of Unmanned Maritime Systems (UMS) that perform a variety of missions including mine countermeasures, maritime security, hydrographic surveying, environmental analysis, special operations, and oceanographic research. While these unmanned systems were rapidly developed and fielded to meet immediate warfighter needs, some of the systems have not been subjected to the normal cost reviews associated with programs of record and in many cases the data required to develop rigorous cost models is limited or unavailable. As a result, the total ownership cost of unmanned maritime systems is not well defined, particularly the costs associated with operations and support (O&S).

Dr. Diana Angelis and Mr. Steve Koepenick from SPAWAR have been working on a CRUSER funded project to better understand UMS lifecycle costs with an emphasis on the operations and support costs associated with unmanned underwater vehicles (UUV). The first phase of the project brought together subject matter experts from various UMS programs in a warfare innovation workshop held at NPS in March 2015. The workshop participants identified several cost drivers of UUV O&S costs including fleet size, energy requirements, availability, security requirements (including cyber security), and training and retention.

*Figure 1. RDML Rick Williams speaks to participants at the Unmanned Maritime Systems Life Cycle Costs Warfare Innovation Workshop held at NPS 24-26 Mar 2015.*

**Short articles (up to 500 words) for CRUSER News are always welcome submit to: cruser@nps.edu**

Each of the major cost drivers was further decomposed into the system attributes that influence the magnitude of the cost driver. For example, energy is a function of:

- Type of mission, which drives:
  - Area to be covered (which drives range)
  - Time constraints (which drives speed)
  - Type of energy source, which drives:
- Recharge requirements and # of recharge cycles
  - Safety (certification)
  - Storage and disposal

An influence diagram for energy costs is shown in figure 1. This will form the basis for further research into the factors that drive energy cost for UUVs.

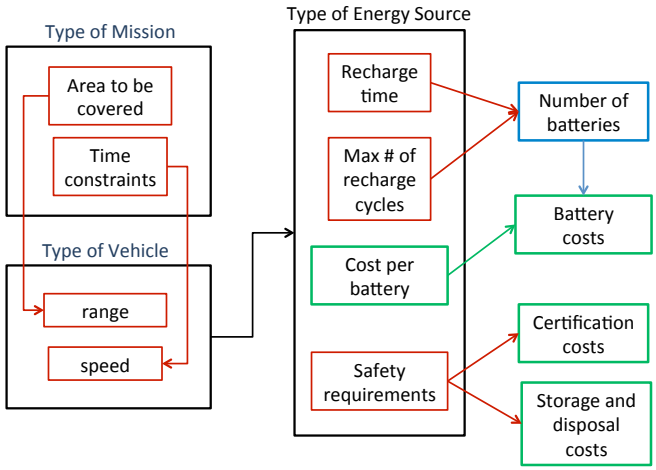



*Figure 2. UUV energy factors*

The next steps are to collect data and build regression models that will quantify the relationships between the factors identified in the workshop and UUV O&S cost categories. When fully developed, these models can be used by program offices to forecast UUV O&S costs in support of analysis of alternatives and budgeting decisions.

Participating in the workshop were several NPS students, including four distance learning students in Systems Engineering. These students decided to use the findings of the workshop as a basis for further research in their capstone project. The capstone project will employ an array of systems engineering methodologies to investigate the specific UUV cost drivers associated with two unique mission types and explore the effect of mission requirements on O&S costs. The team has been working with PMS 408 and PMS 406 to develop point estimates and distributions for relevant O&S cost elements of the life cycle cost model. The project is expected to be completed in March 2016.

# STUDENT CORNER

**Student:** **Salim Unlu,** Lieutenant Junior Grade, Turkish Navy

**Title:** **Effectiveness of Unmanned Surface Vehicles in Anti-Submarine Warfare with the Goal of Protecting a High Value Unit**

**Curriculum:** Operations Research

**Link to Completed Thesis: https://calhoun.nps.edu/handle/10945/45955**

**Abstract:** Littoral anti-submarine warfare (ASW) operations generally focus on deterring and eliminating enemy diesel-electric submarines from transit routes and protecting High Value Units (HVUs), such as amphibious warfare ships and logistics ships. In view of the ASW challenges in the littorals, it is critical to establish and maintain a highly effective ASW capability. The ASW techniques that we use today are mostly effective, but it is important to explore new technologies and techniques—such as potential unmanned surface vehicle (USV) solutions. This study uses an agent-based simulation platform known as Map Aware Non-Uniform Automata (MANA) to model the ASW effectiveness of USVs with the goal of protecting a HVU. The effectiveness of an ASW screen formation is measured by the proportion of successful classifications. The results are analyzed using comparison methods, stepwise linear regression, and regression trees. It is found from nearly 390,000 simulated ASW missions that when helicopters are replaced with USVs, which have the same sensor type and capability, they can provide the same classification effectiveness in an ASW screen formation. The analysis also shows that the most significant characteristic of USVs is the classification range of their dipping sonar.

## CRUSER's New Publication: UNMANNED SYSTEMS SENTINEL Summary

by David Place, NPS Faculty Associate Research, david.d.place@navy.mil

Do you want to know what is happening in the world of unmanned systems?

In order to assist the unmanned systems community in maintaining situational awareness of what is happening in an ever-changing market space, an Unmanned Systems Sentinel publicatoin has been developed to help capture current information regarding unmanned systems development. This summary focuses on platforms from all of the unmanned systems domains, associated payloads and ancillary equipment that support the unmanned infrastructure. The "Unmanned Systems Sentinel" is generated by reviewing and collecting unclassified, daily, open source news articles from a variety of publications. The intent is to provide general atmospherics of operational, legislative and military developments regarding all unmanned systems.

The proliferation of unmanned systems platforms and their associated payloads continues to evolve at a frenetic pace. Maintaining situational awareness of the progression of these technologies is not a trivial task and requires continuous research and assessments. While unmanned aircraft systems have been on the leading edge of development for many years, the unmanned maritime systems and unmanned ground systems are now key elements of the unmanned community.

The Sentinels are usually published twice a week and each edition has approximately 20 current news articles. A weekly summary is also generated to capture the highlights of the most recent two editions. The weekly summaries are posted on the CRUSER website: http://my.nps.edu/web/CRUSER

If you would like to receive the more frequent, weekly Unmanned Systems Sentinels, please send your contact information to David Place (david.d.place@navy.mil) and your email address will be added to an Unmanned Systems distribution.

## Librarian's Corner

Unmanned Aircraft Systems (UAS) at Airports:
A Primer http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_144.pdf

Goldstein, Cora Sol. "Drones, Honor, and War." Military Review, 95, no. 6 (November-December 2015): 70-76
http://usacac.army.mil/CAC2/MilitaryReview/repository/English-2015-Archive.asp#novdec

Tedesco, Matthew "Countering the Unmanned Aircraft Systems Threat." Military Review, 95, no. 6 (Nov-Dec 2015): 64-69
http://usacac.army.mil/CAC2/MilitaryReview/repository/English-2015-Archive.asp#novdec

## Joint Interagency Field Experimentation - Call for Experiments for Feb 2016 event

by Tristan Allen, NPS Faculty Associate Research | Field Experimentation, tmallen@nps.edu, http://my.nps.edu/web/fx

The Naval Postgraduate School's Joint Interagency Field Experimentation (JIFX) program is now accepting Experiment Proposals for its remaining Fiscal Year 2016 events:

- JIFX 16-2: 9-12 February 2016 at Alameda, CA
- JIFX 16-3: 9-13 May 2016 at Camp Roberts, CA
- JIFX 16-4: 8-12 August 2016 at Camp Roberts, CA

Interested parties are encouraged to visit the JIFX website(http://my.nps.edu/web/fx) to review the event Request for Information (RFI) document, submit an Experiment Proposal, and review important due dates. The RFI document outlines the parameters for participation and lists the areas of interest for the event. Applications will be accepted that relate to any of the RFI areas of interest.