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Consortium for Robotics and Unmanned Systems Education and Research



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

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Special Edition

ROBOT ETHICS AND FUTURE WAR (PART II)

by CAPT (ret) Wayne P. Hughes, Jr., USN, Professor of Practice, NPS, whughes@nps.edu

TACTICS AND TECHNOLOGIES

In November 2010 the Naval Institute published its robotics essay contest winner, “How to Fight an Unmanned War,” by Lieutenant James E. Drennan, a student in the Systems Engineering Analysis curriculum at the Naval Postgraduate School. It is a brilliant piece, not least because it is oriented around tactics. Drennan answers the who, where, when, how, and why questions of combat that incorporates robots. A runner up in the competition is on the Naval Institute web site: “Our Own Worst Enemy: Institutional Inertia and the Internal Challenges of Embracing Robotics” by a former Marine, Nathan Hughes (no relation). He contends that the greatest resistance to the development and deployment of robotic systems is neither in the research and development community nor outside the Department of Defense. It is systemic within DoD, created by “a robust and layered series of barriers to [the fulfillment of their potential].”

Both writers are over the top in their criticisms, as any visionary is allowed to be. Neither seems aware of a Naval Postgraduate School program for rapid development and deployment of UAVs with a direct pipeline to the Special Operations command. Our work at NPS shows how to exploit technology quickly by fostering bottom-up pressure from the working level of soldiers, Marines, and Special Forces in Afghanistan and Iraq to overcome the inertia and impediments at the top described by Drennan and Hughes. Most of our unmanned systems are not yet autonomous, but progress may come faster than most people expect. The broad-ranging Naval Postgraduate School CRUSER program is developing autonomous defensive swarms to fight swarming manned or unmanned attackers. We are also pursuing tactics and technologies for autonomous surface and underwater vehicles.

Perhaps the two Naval Institute articles will help foster what is probably the greatest need in the immediate future, which I believe should be to develop new tactics for cooperation between manned, unmanned, and autonomous aircraft. If cooperative robotic operations potentially offer the biggest tactical-technological reward across the armed forces, then the Navy’s biggest operational problem is probably to decide where robots will be based. Unmanned aerial vehicles can fly from large carriers, smaller amphibious ships, small warships like the Littoral Combat Ship, or most affordably of all, from commercial ships adapted to the purpose.¹⁰ One thing seems certain: there is no single solution that fits all tactical needs and all sizes of UAVs. There are equally complicated questions about the employment of autonomous surface and underwater vehicles that go hand in hand with technological advances.

In my view, more attention to the ethical issues can be a positive force in recognizing the tactical and technological future that is closing in on all the armed forces of the world. American military leaders too readily assume they are the only experts in all aspects of warfare. Missiles, unmanned vehicles, and robots are cold blooded. Ethicists emphasize their heedless cruelty as a vice. Soldiers ought to emphasize their coolness under fire as a virtue. A robot won’t panic, or duck, or flee, or lose its temper. Analyzing robot warfare will be easier than analyzing combat between humans when both mind and spirit are prominent. Against human opponents the purpose of gunfire is often as much to destroy enemy morale or make him keep his head down as it is to kill him. Robots never wince.

All opinions expressed are those of the respective author or authors and do not represent the official policy or positions of the Naval Postgraduate School, the United States Navy, or any other government entity.

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GEOPOLITICS AND ECONOMICS

At the Commonwealth Club I said the Weinberger Doctrine was more useful than Just War Doctrine because it was intended specifically to guide decisions by the United States. In closing I said, “States do not kill the enemy; soldiers do. If our nation requires its soldiers to take an oath to defend their country, then it owes its soldiers an accounting of the conditions under which they may be sent to war. . . Contrariwise, the state owes its citizens a dependable army who will fight for them when the conditions are met.” But the Weinberger doctrine is obsolete and needs to be replaced, not least because it was promulgated during the cold war when the Soviet Union was the focus of attention.

In the spirit of the Air Force officer who said an ethical nation should not hesitate to develop robots that will save American lives, how might a moral doctrine of war be framed today—a “Gates Doctrine” as it were? The need is the more compelling because the U. S. economy is overextended and hurting. When the Chairman of the Joint Chiefs of Staff was asked recently what was the biggest threat to the country, he said it was our economic health. A significantly smaller defense budget seems inevitable and will entail more risks than are prudent if national defense were paramount. We will need to pick our fighting machines carefully, including the integrated roles of unmanned vehicles that increasingly will operate autonomously.

The modern world fights in a twilight zone between war and peace. World War II was the last declared war. Conflict since then, violent or non-violent, has been in the spectrum that is neither. The United Nations Organization muddled rather than clarified the distinction. The Korean War was formally a police action and it still not over; the full weight of the UN against North Korea has been unable to bring it to a formal conclusion. To block the movement of nuclear missiles into Cuba the U. S. invented the term “quarantine” because a blockade was an act of war; the contemporary arcane term is maritime interdiction. Moving further toward the non-violent end of conflict that is neither war nor peace we find economic “warfare;” its means of “fighting” have been greatly enhanced by computer technology. Reconnaissance, essential for maintaining stable deterrence of violence, entailed U-2 and SR-71 aircraft operated by the CIA that were arguably an invasion of Soviet air space. One might be tempted to paraphrase an old Army slogan made famous by General MacArthur: Old wars never die; they just fade away for awhile.

A DOCTRINE OF CONFLICT FOR THE UNITED STATES

Implementing an ethical doctrine of just violent or non-violent conflict that is internationally accepted is not possible. Robots and computers are new wrinkles and, as George Lucas suggests, other complicating possibilities are impending, such as laser weapons, and small, inexpensive, long range, very-high-speed missiles that destroy by kinetic energy rather than high explosives. That is all the more reason why the U. S. should have a declared unilateral doctrine for today. We should be guided by a viable but affordable set of national goals. I am no strategist, but here is my best shot at an American doctrine for conflict. It has five provisions with some new elements and some worrisome gaps. If these five goals are not the wisest ones, then they nevertheless illustrate what could be a concise, published policy that is more focused than existing guidance. They are listed in order of frequency of occurrence and in inverse order of deadliness and destructiveness.

I. The nation will maintain the capability to attenuate cyber attacks, including active defensive and offensive operations. [The three unique things about cyber operations are, first, they are going on right now and cannot be completely stopped; second, cyber attacks are non-lethal but they can be very destructive to the American economy and living conditions; and third, cyber operations contribute in wartime by communications security and communications countermeasures against an enemy. A sensible but intricate policy should be constructed by the National Security Council in cooperation with the National Security Agency and the Departments of Defense and Homeland Security, with advice from other departments and agencies.]

II. The Departments of Defense and Homeland Security will defend the homeland from terrorist attack within the limits of affordability and be capable of conducting offensive operations overseas against non-state organizations who threaten the nation.

[I have included an explicit “affordability” clause because there is no hope of buying a disaster-proof defense. An affordable strategy would continue to make such an attack difficult to achieve, but would put more emphasis on organized disaster relief at home and endorse preemptive attacks on the sources. No hint of action only as a last resort is intended.]

III. The Department of Defense will maintain the military capability to fulfill our treaty obligations worldwide. [These alliances include NATO, Iraq, Japan, and South Korea. Here, an affordable capability is not the issue because the forces entailed can be much the same as those designed to influence China in provisions IV and V. Though the treaties are defensive in nature, any of them could escalate into devastating, costly war. For a great power there is no avoiding each commitment, short of terminating the alliance. The hazard of treaty escalation makes the hazard from U. S. robot attacks pale by comparison. Iran is a distinct and difficult case that illustrates the danger. Either of two American military actions might be become necessary, one being to keep the Strait of Hormuz open to international traffic, the second being to prevent Iran from using or selling nuclear weapons—in both cases one would hope without having to invade Iran.]

IV. The Department of Defense will create the military capability to retain influence with our friends in Asia. [Implicit is new respect for China as our emerging peer competitor whose ambition is to be the hegemon of Asia. The U. S.

Director's Corner

Ray Buettner, CRUSER Director



This edition highlights the synergistic aspects of the CRUSER community. Captain Wayne Hughes' continues his exploration of policy by tying the past to the future as he sees it. His thinking, along with the writings of other CRUSER members, was used to motivate our latest Robot Ethics discussion. Dr. Martin Jeffries (ONR) discusses the impact of shrinking Arctic sea ice on naval operations. Ms. Lyla Englehorn describes TechCon which included several NPS projects focused on UXS operations in extreme environments such as the Arctic. CRUSER continues to increase mechanism for academic and commercial participation in our activities so keep those suggestions coming!

strategy in response should specify that (1) we will not fight a land war with China; (2) we will not attack targets in China first, neither with nuclear weapons nor conventional air or missile strikes, but we will have a secure retaliatory capability; (3) we will keep the China Seas safe for commercial shipping for all the friendly nations of the world; and (4) we will realign the U. S. Navy for a maritime strategy comprising forces that respond to unwanted Chinese actions against our Asian friends with step-by-step actions at sea to curtail or prevent Chinese export of goods and import of energy, first with forces for distant blockade and second, with submarines for attacks in the China Seas themselves. These actions can only be taken when world opinion endorses American action at sea, because there will be dire economic consequences for all. Yet the strategy is our best hope to keep the competition peaceful because the greatest penalties from a war at sea will be suffered by China. The capability is affordable, but it will take a preponderance of the Navy's budget.]

Nothing in the Weinberger Doctrine distinguishes the extraordinary destructiveness of weapons of mass destruction. Nor is it covered in classical just war doctrine, when such weapons did not exist.¹¹ The U. S. has never expressed a formal doctrine against first use of its arsenal of nuclear weapons. Yet this would seem to be the single most important policy decision of a great power, if for no other reason than to set an ethical example for other states.

V. The Nation will maintain a secure, nuclear retaliatory capability to devastate another state that employs a weapon of mass destruction.

[On one hand the doctrine implies no first use of nuclear weapons.¹² On the other hand, it is explicit that "overwhelming force" is intended by the policy. This is widely thought to be the best deterrent of an attack by another state that has nuclear, chemical, or biological weapons. There is no question of a proportionate response. This departs from just war doctrine, but the policy must be just if the threat prevents first use by another state. Our use of nuclear weapons is clearly contemplated to aid an ally such as Japan if it is attacked with them, as indicated in provision III. U. S. employment of nuclear weapons when another state, such as Israel, suffers a nuclear attack is not explicit and ambiguous. The policy applies only to sovereign states. Nuclear retaliation on terrorists is difficult, undesirable, and in many instances impossible. The doctrine for action against non-state entities is covered in provision II.]

In the 1980s when the Weinberger Doctrine was in effect the defense budget was much bigger and our armed forces larger. For example, the Navy had twice as many ships. The doctrine was a unique thing, valuable in the 1980s in constraining American military action. But Secretary of State George Schultz thought it stifled flexible negotiations, which was why it was never the "Reagan Doctrine." I admit that today "the Gates Doctrine," or better yet "the Obama Doctrine," is not likely to be formulated and published—one would wish in consultation with the American Congress. Nevertheless it ought to be constructed—to guide affordable American military plans and policies in the difficult years ahead.

¹⁰ *Relatively low cost Q-ships and spy ships and aircraft are antecedents.*

¹¹ *That said, when just war doctrine was formulated, war was brutal. I am not thinking of the means employed by the Roman Empire but by the Tartars and Mongals at the peak of their effectiveness.*

¹² *I personally would prefer to be explicit. The U. S. has never been able to make such a declaration, although it seems settled policy that we will never initiate chemical or biological warfare.*

CALL FOR ARTICLES: UNMANNED UNDERWATER VEHICLE (UUV) WEEK, JUNE 1-5

During the first week of June, the Center for International Maritime Security (CIMSEC) will host a series focused on the development, application, and unique challenges of Unmanned Underwater Vehicles (UUV). As such, this is a general call for articles concerning UUVs. Articles should be between 700-1700 words in length and must be submitted no later than 25 May. Contributions may address the utility of UUV platforms to address the Navy's evolving needs, the challenges of their application, their contributions to a particular mission or strategy, or some other facet of UUVs. Publication reviews will also be accepted.

<http://cimsec.org/call-articles-unmanned-underwater-vehicle-uuv-week-june-1-5/16338>

CRUSER TechCon & Robots in the Roses Research Fair

by Lyla Englehorn, CRUSER Director of Concept Generation

April 2015 was the month of CRUSER! We started our celebration of National Robotics Week with CRUSER TechCon 2015 on Tuesday and Wednesday 7-8 April. This year's technical continuum included 30 presentations over two days, ranging from unmanned undersea vehicle under-ice operations to airworthiness assessment models of unmanned aerial vehicles to data farming methods. Much information was shared, and the presentations were better attended than in years past. Although the chance of severe weather chased us indoors on the first day, we were able to use The Tent on The Quad for day two adding a festival flair to the event. Abstracts for all presentations are posted at <http://CRUSER.nps.edu>. Click on 2015_04 TechCon under CRUSER Events.

On Thursday 9 April we brought our celebration out on The Quad for the 5th Annual Robots in the Roses Research Fair. The first CRUSER research fair was held in March 2011 in the rose garden, hence the "Robots in the Roses" event title. Each

Spring we gather campus researchers to showcase their work, and have also generated quite a bit of interest from the local elementary and secondary school communities. This year's event attracted guests from San Carlos School, Bay View Academy, and River School to name a few. Several local high school robotics teams showcased their recent competition entries as well. New this year were guided lab tours of eight unique spaces on campus. These tours allowed researchers to showcase work not easily transported outside, and allowed guests to see the breadth of work we do here at NPS related to robotics and unmanned systems.

Finally, CRUSER Robo-Ethics 2015 gathered students from NPS, fleet participants at SSC PAC, and the USNA community in Annapolis to explore the operational limits to military robotics. Their outcomes will be summarized in the June 2015 issue of CRUSER News – stand by!

Additional information about TechCon is available at: <http://www.nps.edu/About/News/Student-Research-Examines-Utility-of-Open-Source-Software-for-UAVs.html>



Professor Kevin Jones giving a presentation during TechCon and demonstrating the flight of a quadrotor during Robots in the Roses

Librarian Corner

A Game of Drones: Comparing the U.S. Aerial Assassination Campaign in Yemen and Pakistan

<http://hdl.handle.net/2346.1/30273>

Responding to Russia after the NATO Summit: Unmanned Aerial Systems Overmatch in the Black Sea

<http://ndupress.ndu.edu/Portals/68/Documents/defensehorizon/DH-79.pdf>

Unmanned Aerial System Threats: Exploring Security Implications and Mitigation Technologies [House hearing]

<http://homeland.house.gov/hearing/subcommittee-hearing-unmanned-aerial-system-threats-exploring-security-implications-and>

Unmanned Aircraft Systems: Key Considerations Regarding Safety, Innovation, Economic Impact, and Privacy [Senate hearing]

http://www.commerce.senate.gov/public/index.cfm?p=Hearings&ContentRecord_id=edf8ac57-d9a5-4bf8-9938-2017a3e89fd0&ContentType_id=14f995b9-dfa5-407a-9d35-56cc7152a7ed&Group_id=b06c39af-e033-4cba-9221-de668ca1978a

Drone Crash Database

<http://www.washingtonpost.com/wp-srv/special/national/drone-crashes/database/>

As Arctic Sea Ice Shrinks, Navy Interest Grows

by Dr. Martin Jeffries, Arctic Science Advisor & Program Officer for Arctic and Global Prediction, ONR, martin.jeffries@navy.mil and Dr. Heather Havens, Arctic Policy Analyst for Navy Strategy & Policy Directorate (OPNAV N51), hhavens@cydecor.com

If there is one thing we know about the Arctic, it's that there's a lot we still don't know. We do know that rapid change is occurring throughout the Arctic environmental system, as described annually in the Arctic Report Card¹. The challenge is to understand how the system works and why it's changing, and to predict what it will look like in the future.

Recognition of the need to understand the ways in which the region is changing and the potential impacts of these changes was among the primary drivers behind the Navy's recent update to its Arctic Roadmap. The U.S. Navy Arctic Roadmap 2014-2030² includes an assessment of current research on sea-ice projections and concluded that reductions in winter maximum and summer minimum ice extent are likely to continue. As a case in point, on February 25, 2015, Arctic sea ice reached its maximum extent early and, more significantly, it was the least amount of end-of-winter ice recorded since satellite observations began in 1979.

The impact of reduced sea ice cover remains uncertain and will require a collaborative effort to develop weather and ice data collection, modeling and forecasting. The Roadmap identifies shortfalls in ice and weather observation and prediction as gaps that need to be addressed in order to safely operate in the rapidly changing environment. At a national level, the President's Implementation Plan for the National Strategy for the Arctic³ calls for the development of a "Framework of Observations and Modeling to Support Forecasting and Prediction of Sea Ice."

In response to the Navy's Arctic environmental observation and prediction needs and in support of the President's Implementation Plan, the Office of Naval Research (ONR) conducted an ambitious Marginal Ice Zone⁴ (MIZ) field experiment in 2014. Researchers from the United States, United Kingdom, France and South Korea participated in the largest field experiment of its kind ever conducted in the Arctic Ocean. What distinguishes the MIZ experiment from others is the minimal human presence and the reliance on a large array of robotic technologies for observing the atmosphere, ocean and ice from the time of maximum ice extent in March until minimum extent in September.

By the end of summer 2014 over 100 autonomous platforms had been deployed to measure the weather, snow depth, ice thickness and temperature, ocean surface waves, and water



temperature, salinity, currents and fluxes below the ice and in open water. Of particular note was the successful operation of four Seagliders⁵ with navigation and communication services provided by underwater acoustic sources. The field observations were supplemented by hundreds of synthetic aperture radar (SAR) and electro-optical satellite images.

The results from ONR's 5-year MIZ experiment (2012-2016) will provide Navy with an increased knowledge of the physical environment in the Arctic, ultimately aiding future safe navigation and operations in the region. The MIZ experiment also goes a long way towards addressing the objectives the Navy and the President have laid out in their Arctic policies, but there is still much important work to be done. For this reason, ONR is mounting another major field experiment in fall 2015 to investigate "Arctic Sea State and Boundary Layer Physics." Stay tuned.

1. *Arctic Report Card Update for 2014: Tracking Recent Environmental Changes*. 2014. <http://www.arctic.noaa.gov/reportcard/>
2. *U.S. Navy Arctic Roadmap 2014-2030*, <http://greenfleet.dodlive.mil/files/2014/02/USN-Arctic-Roadmap-2014.pdf>, February 2014
3. *Implementation Plan for the National Strategy for the Arctic Region*, https://www.whitehouse.gov/sites/default/files/docs/implementation_plan_for_the_national_strategy_for_the_arctic_region_-_fi....pdf, January 2014
4. *Marginal Ice Zone (MIZ): the region where the frozen ocean meets the open ocean*.
5. *Seaglider™: an autonomous underwater vehicle (AUV) or underwater glider developed for continuous, long term measurement of oceanographic parameters*.

Short articles (up to 500 words) for CRUSER News are always welcome

submit to: cruser@nps.edu

CRUSER Monthly Meetings

Mon 18 May, 1200-1250 (PDT)

Mon 1 Jun, 1200-1250 (PDT)

details at <http://CRUSER.nps.edu>

STUDENT CORNER

STUDENT: LCDR Maxine Gardner, USN

TITLE: Investigating the Naval Logistics Role in Humanitarian Assistance Activities

CURRICULUM: OPERATIONS RESEARCH

LINK TO COMPLETED THESIS: [HTTPS://CALHOUN.NPS.EDU/HANDLE/10945/45189](https://calhoun.nps.edu/handle/10945/45189)

ABSTRACT: According to Department of Defense (DOD) Instruction 2205.02 (June 23, 2014), DOD components must conduct humanitarian and civic assistance (HCA) activities in response to regional conflicts or natural disasters. The Under Secretary of Defense for Policy determines how HCA policy is coordinated and implemented within the DOD and delegates responsibility to the regional combatant commands. In past modeling efforts for disaster relief, stochastic optimization has been utilized and produced promising results; however, the deterministic nature of optimization models may not fully capture the uncertainty that is inherent in natural disasters and the demand created by them. In order to better understand the effects of the uncertainty surrounding natural disasters and realize a robust logistical response to these events, new approaches are necessary. This thesis develops an asset allocation optimization model for naval logistics, and then uses experimental design techniques to systematically explore solutions to the model. Our analysis reveals the importance of robust planning for natural disaster response to ensure that demand is met and a quick response is possible. Finally, we explore the use of unmanned aerial vehicles as logistics assets, and show that they have the potential to add much benefit to foreign humanitarian assistance.

Mine Warfare Unmanned Systems: US Allies are moving forward

By Dr. Franck Florin, CRUSER Member, VP International Technologies, Thales Defense & Security Inc.

During World War II, mines emerged as a major weapon and the British, German and American navies placed more than 215,000 mines in the seas (according to Chris Henry, Depth Charge, 2005). To date, despite constant clearing effort, more than 60% of the mines and unexploded ordnances from that period are still lying on the sea bed near European harbors and along major European navigation channels. In 2012 alone, the French Navy neutralized a total of 2,292 explosive devices in the country territorial waters (50% in the Channel between France and UK, 30% in the Atlantic and 20% in the Mediterranean Sea).

With tens of thousands of unexploded ordnances to clear and many international operations abroad to support United Nations peace keeping and NATO crisis management, the European navies need cutting edge technologies to support their Mine Warfare (MIW) effort. This was recognized by the European Defense Agency (EDA) in November 2008, when the agency initiated a Maritime Mine Counter Measures (MMCM) project with thirteen contributing Members (France, as lead nation, The United Kingdom (UK), Belgium, Estonia, Finland, Germany, The Netherlands, Poland, Portugal, Romania, Spain, Sweden and Norway). During a two year assessment phase, the nations shared military requirements and looked at available technologies enabling the replacement of existing Mine Hunting capabilities.

Moreover, for both France and The UK, MIW is essential to sustain SSBN forces. France and the UK have therefore assigned millions over the years in developing the most capable MIW forces. In 2010, France and The UK signed the Lancaster House treaty for defense and security cooperation, agreeing in particular MMCM collaboration and Unmanned Systems Research & Technology focus.

The Organization for Joint Armament Cooperation (OCCAR) is an international organization created by six European nations (Belgium, France, Germany, the UK, Italy and Spain), whose core-business is the through life management of collaborative defense equipment programs. In July 2012, EDA and the OCCAR signed an Administrative Arrangement, paving the way for a closer relationship and highlight-



Figure 1: Representation of MMCM concept (Courtesy of Thales)

ing their common interest, especially regarding MMCM. The same year, UK and France aligned their plans regarding their future MMCM capabilities and decided to develop and realize prototypes of new MMCM systems based on unmanned technologies, under OCCAR program management.

OCCAR began immediately a European competitive process for a common assessment phase. On March 27, 2015, OCCAR officially awarded the MMCM contract to a Thales led consortium with BAE Systems on behalf of France and The UK. The MMCM program will develop autonomous unmanned systems for detection and neutralization of sea mines and underwater improvised explosive devices (IED). The first objective of the OCCAR-managed MMCM Program is to develop, manufacture and qualify two prototype systems, combined to deliver agile, interoperable and robust MMCM capability. By defeating underwater mines and IED in stride, these systems will give strategic, operational and tactical freedom of maneuver to the forces. The four stage schedule includes design, manufacture, qualification, and will end with a 24 month operational evaluation (OPEVAL) by the Royal Navy and the French Marine Nationale.