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# Weaponizing UxV's

**UxV.** The unmanned vehicle business has generated a new acronym, UxV, signifying the family of Unmanned Aerial Vehicles, Unmanned Undersea Vehicles, Unmanned Ground Vehicles, Unmanned Combat Air Vehicles and Unmanned Surface Vehicles. This paper proposes a program to weaponize UxV's with munitions technology specific to the application, fully integrated with the various types of UxV's based on common design principles, achieving much higher performance than would otherwise be attained.

**Use of UAV's to deliver Weapons.** The capability to deliver munitions from UAV's is established and in use by US forces in Iraq and Afghanistan. The delivery of Hellfire missiles from Predator UAV's is mentioned in press reports of combat actions. The technology of these applications of UAV's in combat is based on deploying weapons originally designed for delivery by conventional manned aircraft and adapted for use with Predator, a large, long range UAV. The generous size of Predator makes for a relatively straightforward adaptation of the Hellfire manned aircraft weapon for delivery from a remotely directed unmanned aircraft. The fielding of the MQ-9 Reaper brings on-line a system with six times the external payload of Predator. Instead of making the weapons smaller with greater specific energy, the USAF is making the aircraft larger. Larger aircraft, of course, require more fuel, more facilitization, more maintenance support, and less flexibility in the terms and conditions of deployment

**Technological Basis.** The underlying technologies of unmanned systems capabilities are associated with remarkable advances in micro-electronics, sensors and computation over the past 50 plus years. And, the pace of technological advance in these areas is accelerating, accommodating aggressive pursuit of more and more advanced capabilities to perform more complex tasks with decreasing physical size. Smaller UAVs and a growing number of UGVs are performing a variety of roles in Iraq and Afghanistan. These unmanned systems are becoming increasingly ubiquitous on the battlefield. Indeed, according to the 2008 Army Modernization Plan, there are currently 4,000 such systems in Iraq.

**Strategic Need.** The use of UAV's to deliver ordnance finds favor with military and political leaders because it reduces the exposure of service members to hostile fire. It is a reasonable generalization to say that the American public has relatively low tolerance for battlefield casualties. We observe, in the case of the conflicts in Iraq and Afghanistan, that what began with broad support to commit forces to defending American interests in war, was followed by building angst as to the consequences and costs in the death and disability of young Americans and increasing concern for the welfare of non-combatants in the war zones arising from the resulting propaganda and humanitarian issues. Precision weapons and unmanned vehicles are technologies that help to mitigate the American public's sensitivity to the inhumanity of war.

**Operational Need**. Unmanned systems allow for extended time on station than manned systems. Longer loiter time provides sustained coverage and provide greater support to warfighters. Unmanned systems eliminate the risk of casualties (and of capture of personnel) in

undertaking dangerous operations in areas where commanders would otherwise hesitate to strike. Moreover, they significantly reduce the reaction time and time to target equations allowing fleeting targets to be struck. Finally, they hold the potential for achieving affordable precision effects to minimize collateral damage while achieving significant tactical impact.

**UxV Design.** UxV's have in common the underlying technologies of micro-electronics (here the term is used as a shorthand for the size range from nano to simply small and compact), advanced computation, sensors and actuators. These technologies dominate the traditional platform associated engineering disciplines such as aerodynamics or naval architecture in driving the technology forward to achieve new capabilities. Very importantly for UxV's, miniaturization of everything is critically important. The ideal UxV is small and cheap but has large payload, high speed, long range and the endurance to achieve persistent presence. These are not really different than the dream requirements for manned vehicles, but they are compelling for UxV. A large, support intensive, unmanned system that begins to approach a manned system in acquisition and support costs is clearly unattractive. For the foreseeable future, manned systems, employing the matchless adaptability of the human being, will perform a broader range of missions more flexibly than unmanned systems. For the UxV to carve out capability niches for missions of the greatest danger, very great pressure develops for even more intensive miniaturization than has been experienced by the designers of manned systems, so that the UxV will be smaller and much less costly than potentially competing manned systems. (Another version of this argument delves into the economies of scale. Vehicle volumes relate to paying the volumetric overhead for basic functionality and using what remains for payload and fuel. But the determinants of mobility limits are generally associated with surface area. So, as vehicles become smaller the volume to surface area ratio is getting smaller by the principal length dimension. A simple example of this principle is the economics of cargo ships for which bigger ships enable lower freight rates until some limit like ability to get through a canal or into a port is reached.) In the case of UxV's carrying weapons, it makes system design sense to make the weapons as small as possible for the desired capability. So along **with investment in the technologies associated with the basic UxV functionality, there should be associated investment in the munitions they may be designed to carry, and development of new paradigms for systems engineering/systems integration of UxVs.** For these weapons "More bang for the buck!" will take on greater significance than ever before.

**Weaponizing UxV's.** UxV's need a new family of weapons designed for the application. In order to achieve desired capabilities in these weapons **new integrated energetics will need to be developed** so that these new weapons will deliver greater weapon effects with more precision than has here-to-fore been the case. Since the advent of the concept of precision weapons most weapon design innovation has concentrated on the weapon controls and sensors placing the warhead on the intended target with exactitude. The ensuing detonation of the energetic materials in the warhead has received minimal attention. Of course, there have been design changes in packaging, innovations in fusing, and advances in insensitivity to diminish risks in weapon storage and handling, and for some weapons enhancements in weapons effects associated with the application of shaped charge technology. But, the drumbeat of weapon design has been precision. Indeed, the technology of precision in weapons such as TOMAHAWK is a part of the foundation of UxV technology. What is a TOMAHAWK, but a UAV with an attitude destined for a one way trip? The same can be said of the most advanced undersea weapon, the Mark 48

ADCAP torpedo, a UUV with attitude. The TOMAHAWK is the predecessor of the weaponized UxV also, in that the missile can carry several different kinds of warheads, some of which deploy sub-munitions upon arrival in the vicinity of the target.

**Energetics Advances Applied to Weaponizing UxV's.** Advanced munitions technology would emphasize new design approaches based on advanced energetics engineering concepts. There have been modest efforts made to date in adapting existing weapons to new platforms, but what is suggested here is an entirely new idea of simultaneously developing both the munitions suite and the platform, in order to achieve maximum combat effectiveness, and precise, target-adaptable systems. Three applicable energetics advances in various stages of application are:

- Fully integrating the munition explosive and propellant with the design of the warhead or missile, treating the missile structure, propellant and explosive as a single system in which structure would be designed from reactive metals like aluminum or magnesium configured to participate with residual propellant and explosives in the final detonation so that in effect the entire munition is warhead. DARPA is just beginning a project along this line of development.
- Further development of thermobaric technology building on work supported by DTRA.
- Micro electrical mechanical systems (MEMS) fusing for reducing the weight and volume of the munition fuse being developed at Indian Head Division of the Naval Surface Warfare Center.

**Specific Proposal.** It is proposed to complement the family of existing technologies that already feed into advancing the capabilities of UxV's by adding the technology of advanced munitions specifically developed for UxV weapon deployment. NWSC-Indian Head and the Army Research laboratory, in conjunction with the Energetics Technology Center and the University of Maryland's Center for Energetic Concepts Development, propose to develop a roadmap, timeline and executable plan to provide the energetics technology necessary to effectively weaponize UxV's to deliver precision effects. The plan would have the specific purpose of attaining highly effective systems in terms of their capability to destroy a broad range of threat targets with little collateral damage, but packaged in smaller, lower weight configurations that allow the UxV to deliver on the promise of "More destructive energy applied directly to the target maximizing the utilization of precious UxV payload capacity for minimum overall system costs" The plan would include an evaluation of weapon system engineering methodologies presently in place and recommendations for new paradigms to get the job done effectively.

Footnote: the terms weapon, munition, ammunition, and ordnance seem, in common practice, to be used somewhat interchangeably. In the paragraphs above the term "weapon" is used in the sense of a missile or torpedo. The term "munition" is used in the sense of the final component of the weapon that arrives at the target and detonates, often called the warhead. The essence of weaponizing UxV's is to create a small weapon that is all or very nearly all munition or warhead and that has the effectiveness of a larger conventional weapon of today.

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