

## **Author**

John S. Canning  
Chief Engineer, G80, Naval Surface Warfare Center, Dahlgren Division

## **Title**

# **Weaponized Unmanned Systems: A Transformational Warfighting Opportunity, Government Roles in Making it Happen**

*“The only thing harder than getting a new idea into the military mind is to get an old one out.”  
B.H. Liddell Hart (Thoughts on War, 1944)*

## **Abstract**

Armed fully-autonomous unmanned systems offer a new paradigm for conducting warfare in which it may be possible to disarm a foe, instead of killing him. This stems from Law Of Armed Conflict considerations wherein a machine is not allowed to automatically target the human “archer,” but could be allowed to automatically target either his “bow,” or his “arrows.” The legal precedent for doing this has already been set many times over. It represents a fundamental paradigm shift in how warfare could be conducted.

Fielding of such a system is an inherently governmental role on many levels, from the setting of the basic requirement, to the funding of development. There are appropriate roles for contractors to play, but under the firm direction and guidance of government personnel.

## **Introduction**

An Article from “The Integration Papers” of the Naval Warfare Center:

This paper is one of a series of papers developed by the Naval Warfare Center to coalesce current thoughts on the myriad of technical disciplines and processes necessary to develop, technically husband and ultimately bring to fruition a large scale highly complex system of systems article of war. The origin of these papers came about in response to the ever increasing development cost and technical complexity of major weapon systems and the increased role of systems integration in achieving a successful outcome. It is through these papers, and the professional dialogue that ensues, that a historical perspective of the government’s technical role in these national endeavors can be better understood and future roles and responsibilities of all technical participants be better aligned for success. For there is nothing more complex, more demanding of engineering mastery, more dominating the world over and yet more sensitive to catastrophic system failure than the Naval warship at sea defending our nation, yet that is what a war ship is built to do.

In this paper we shall describe considerations for the weaponization of fully-autonomous unmanned systems and how this fits into the constitution of Large Scale Complex Systems Integration roles, responsibilities and necessary functions.

## **Background**

In determining the requirements for weapon system development, one always begins with a statement of need from the warfighter, such as a Joint Universal Operational Needs (JUONS), that addresses the perceived shortfall in dealing with a particular threat. To this, we add an official statement of the threat from an approved intelligence source, such as the Office of Naval Intelligence, as an example, that describes the threat in enough engineering detail that we can begin to synthesize a system to address the shortfall against the threat adequately. Since we are discussing weapon system development, there is another factor to be considered in this requirements mix: legal constraints. All weapon systems are required to undergo a “legal weapon” review prior to their moving into full-scale production. (This is a requirement of both DODD 5000.1, subparagraph E1.15, and SECNAVINST 5000.2C, paragraph 2.6.) This is to meet international agreements on what is, and what is not, allowed in weapon systems. These constraints provide some very fundamental guidance for weapon system design, so it just makes good common sense to consider them from the very beginning.

The warfighters, being uniformed members of, and listed on the rolls of, our armed forces, provide a uniquely governmental perspective in the generation of requirements, since they are the ones that will be taking the system into combat. Our intelligence agencies, by law, are the sole recognized sources of validated information regarding threats that may be used in the design of any warfighting system, so they represent another uniquely governmental perspective in the generation of requirements. Finally, the Judge Advocate General (JAG) community also brings a uniquely governmental perspective to the requirements-setting process, because they ensure that the design is legal in the eyes of the international community. This latter group has had a tremendous impact on the thought process involved in attempting to produce a viable design for armed, fully-autonomous, unmanned systems.

## **Discussion**

In mid-2003, the author began to take a serious look at what it was going to require in order to weaponize fully-autonomous unmanned systems. (By this, it is meant armed robots that can decide when to pull the trigger – without a human in the weapons control/targeting loop.) At that time, it was seen that the Hellfire-armed Predator Unmanned Air Vehicles (UAVs) were beginning to be used in offensive operations in Afghanistan and Yemen, and other systems, such as the Special Weapons Observation Reconnaissance Detection System (SWORDS), an armed Talon unmanned system, were being developed. The general issue that we saw with these man-in-the-loop systems was this: Today on the battlefield, the soldier is there with his weapon. There is a certain cost associated with putting him and his weapon there. The addition of these unmanned

systems basically inserts an expensive machine between that man and his weapon, thereby raising the cost of conducting whatever mission the man was performing. While this may be tolerable for low numbers of machines, once we begin to field hundreds, or even thousands, cost will become a very definite issue.

Past experience has shown us that, typically, the largest lifecycle cost component of a system is for manpower, and a lot of government-led effort has been expended on programs, such as the CVN-78, to figure-out how to reduce the manning in order to make them more affordable. Examination of unmanned systems efforts, such as the Global Hawk, showed that manning, and associated costs, was a serious issue. Clearly, though, there was no incentive for industry to address this cost issue.

There is a political cost associated with human warfighters as well when they are killed, or seriously wounded – not to mention the political costs associated with the physical, emotional, and financial strain it places on their families during their absence, even if they do return unharmed.

An operational commander must weigh the worth of a particular military objective, against the expected loss of life, and injuries, to his own troops before making a decision to engage, or not. Most people don't realize that he must also make a similar decision regarding loss of life and injuries for the "collateral damage" aspects of an operation – and this will be addressed in more detail later.

How to address the manning issue for armed unmanned systems to make a serious impact on the usefulness, and affordability, of these systems? This, to us, was clearly a governmental responsibility.

From the beginning, it was clear that legal weapon considerations were likely the single biggest issue we would have to deal with, and we decided that if we couldn't solve this problem, then we were just wasting our time. With this in-mind, we arranged a meeting at the Naval Surface Warfare Center Dahlgren, VA on 23 SEP 03 with personnel from both the Navy JAG International Law Division, and the OSD Office of General Counsel, to discuss weaponizing autonomous unmanned systems.

It was clear from the beginning of this meeting that the lawyers were not at all in favor of machines that could deliberately target and kill people with no human in the targeting/weapons control loop. It was the "Why?" of their stance that proved riveting. The lawyers told us the following:

The history of warfare is as old as the history of mankind itself. From the earliest time, man has targeted man with the weapons of the day, be they rocks and stone clubs or Tomahawk cruise missiles. As the destructive capability of weapons has increased, so has the potential for incidental injury to civilians and collateral damage to civilian property. Additionally, military operations have moved to the urban population centers amplifying this risk. The Napoleonic era brought the advent of the theory of "total war," where no parts of the enemy populations or infrastructure were exempt from targeting. At the turn

of the last century, technology had outpaced tactics, and World War I brought the carnage of modern weaponry used in trench warfare. Following WW I, purportedly “the war to end all wars,” was massive destruction wrought by WW II, and the use of the atomic bomb. The rebuilding and reconstruction of Europe and Japan following WW II drove home the consequences of disregarding the ramifications (physically and psychologically) of targeting a civilian population. The conclusion... mass civilian casualties can make it difficult to end hostilities and transition to lasting peace. Of course with the atomic bomb, and then the hydrogen bomb, came the realization that mankind now possessed the power of self-annihilation.

The Vietnam War, dubbed the “living room war” (the nightly news relayed televised coverage and casualty reports), changed the public perception of warfare and of its effect on the combatant and civilian alike. Casualties, whether civilian or soldier, now had a “face.”

The result of the foregoing? Warfare is guided and controlled by a set of rules commonly referred to as the Law of Armed Conflict (LOAC), also known as the Law of War<sup>1</sup>. Simply stated, the LOAC is a means by which mankind has endeavored to reduce the damage caused by his war making. What has evolved over the centuries brings us to the current state of affairs wherein our ability to wage war is heavily constrained by legal and political concerns: As previously mentioned, weapons and weapon systems are subjected to a legal review to ensure compliance with the LOAC, and similarly, the employment of legal weapons and weapon systems may be subjected to Rules Of Engagement designed to limit civilian casualties and damage, and to ensure the proper application of military force consistent with the political goals of the nation.

It was for these reasons that the lawyers were dead-set against robots that could potentially automatically kill women and children, and hence lead them to insist on a man-in-the-loop capability for weapons control if people were to be directly targeted. Now we understood!

Clearly, this insight by the JAG community had developed through international treaties, governmental and academic studies of historic events, the actions involved, and their results. Again, there was no incentive (or proper role) for industry to have done anything like this.

We thought about what the lawyers had told us and noted that they didn't have the same concerns about systems that could automatically target “things,” instead of “people.” In fact, when we began to dig we found that a number of weapon systems already had been designed and fielded that could automatically target the archer's bow, or arrows, but did not directly target the human archer. Some examples: The AEGIS weapon system when placed in AUTO-SPECIAL mode for AAW targets; the CAPTOR mine system that would automatically fire a torpedo at a detected submarine; and the old anti-ship version of the TOMAHAWK cruise missile that would automatically identify and attack specific enemy warships at over-the-horizon ranges. As counterpoint to these examples consider

---

<sup>1</sup> See, for example: <http://lawofwar.org/>

the case with landmines: There are two general types of landmines that we need to consider – anti-personnel, and anti-tank. The use of anti-personnel landmines has been outlawed by the international community because they indiscriminately target humans. (They don't care if the human is a soldier, or a child.) However, the use of anti-tank landmines is still allowed because they target tanks. (Yes, the current ones will also go off when triggered by trucks and cars, but they don't directly target people.)

We discussed this observation with the lawyers, and asked them if they had a problem with armed autonomous systems that would directly target “things,” instead of “people.” The response that we received was that “... each individual design would have to undergo its own legal weapons review.” Again, this review is an inherently governmental activity to ensure that the designs meet restrictions of both international and federal law. We viewed it as a sanity-check to ensure that any design we produced hadn't missed some key point.

Based on this, we began to explore a concept of operations for armed autonomous unmanned systems. The modern battlefield soldier does more than just engage the enemy. For example, he may be expected to gather real-time intelligence on the battlefield by collecting information such as maps, battle plans, and other data from POWs. He may also be charged with determining such minutia as the condition and types of food supplies available to the enemy, or even the condition of the footwear on enemy soldiers. Infantrymen may also be required to secure loose weapons found on the battlefield in order to prevent their use by the enemy.

If we expect to capitalize on the large-scale use of armed unmanned systems on the battlefield, we need to consider how these systems might perform these other tasks. Failure to employ these systems across the broadest possible range of functions may reduce the advantage to be gained from their development, since the basic (human) infantryman would still be needed to perform the remaining functions. Indeed, it may end up costing us much more to field both armed autonomous systems *and* human infantrymen if we do not take this view.

Recall that an infantryman is expected to secure loose weapons found on the battlefield. If we are to do this with an armed unmanned system, we will need a robust autonomous means of identifying a weapon when one is encountered. This leads into the area of Automatic Target Recognition (ATR), and there has been, and continues to be, a great deal of research done in this area. (Note: funding of such research is a governmental function because businesses tend to be risk-averse and profit-motivated.) If we can identify a weapon found loose on the battlefield, chances are that we'll also be able to recognize it if it is being held by an enemy combatant.

## **Results**

The concept of operations would be something like this:

While crossing a battlefield, our armed unmanned systems would scour the battlefield looking for weapons. What occurs after one is found would depend on if it is loose, or if someone is holding it. If it is loose, then our system would secure or destroy it. If an enemy soldier holds it, then he could be directed to abandon his weapon. If he does so, then our system secures or destroys it, and does not attack the enemy soldier. If the enemy soldier chooses not to follow this direction, then our system might use non-lethal weapons to convince him to lay down his weapon. If he complies, then our system proceeds to secure or destroy the weapon. If he fails to do this, then our system would proceed to secure or destroy the weapon while the enemy soldier is still in possession. It is possible that the enemy soldier may be injured (or killed) in this process, however the armed unmanned system should be capable of more accurately directing fire (even using a less lethal fire) than a human infantryman, so it may be able to target the enemy weapon – not the human holding it. If the enemy soldier uses or attempts to use the weapon to fire on our system then this would indicate a “hostile act” or “hostile intent” and could result in our armed unmanned system responding in self-defense against the attacker’s weapon.

This new paradigm of targeting and engaging the weapons of war represents a potential method for armed unmanned systems to determine who and what are legitimate targets on the modern battlefield. Additionally, if the human holding or manning a weapon is compliant in the disarming instructions, his life may be spared. This method of determining who or what a legitimate target is may assist in determining if an armed unmanned system is in fact a discriminate weapon under LOAC. It specifically identifies and targets weapons or weapon systems – not the person manning them.

Consider what the political costs for such a system would be: It is designed to take our human troops off the battlefield, or at least out of the direct line of fire, thereby eliminating the political cost associated with friendly casualties. However, this may not totally eliminate the political costs if “collateral damages” remain high. However, we expect that our systems can be designed to keep collateral damage at reasonably low levels. (Our “dream machine” is one that would confront an enemy combatant on the battlefield; physically remove his rifle from his hands; saw the rifle in half with a diamond-tipped saw; hand the two halves back to him; and then tell him to “Have a nice day!”) The issue in disarming the human enemy is then reduced to the question of if he is carrying the “bow,” such as with a rifle, pistol, or grenade, or if he is riding on it, such as a tank, warship, or helicopter gunship. In the former case, he possibly may be easily separated from his weapon before we destroy it. In the latter case, he has chosen to be onboard his war-making machine. He may also choose to get off, which may or may not be an easy thing to do, but we *are* going to kill his war hardware in any event. This scheme should help to keep collateral damage down to a minimum. (Note that “collateral damage” issues to civilians and property need to be addressed as well, and we think we can do that.)

We would argue that the development of this concept of operations has been, and remains, an inherently governmental function. We submit that this approach presents a fundamental paradigm shift in warfighting, away from attempting to kill an enemy to disarming him, and is core to why this is the case that it is a governmental function.

Regarding the collateral damage issue: Large weapons can cause large amounts of collateral damage. Conversely, smaller weapons tend to cause less collateral damage. In our approach, one must be willing to re-think what a “weapon” is altogether. We are not trying to kill anyone, and our armed unmanned systems have no lives to lose, so they have less at stake with taking the fight to the enemy than our human warriors would have. Our biggest concern is with separating the human enemy from his own weapons so that we may render them unusable. As noted, our “weapon” could be a diamond-tipped saw, or it could be a laser welder. The use of “non-lethal” weapons, such as Active Denial<sup>2</sup>, to separate the human enemy from his weapons gain in importance in order to further reduce collateral damage concerns.

This does not mean that our armed unmanned systems should not defend themselves – far from it! After all, they will likely represent a fair investment of U.S. taxpayer dollars, and we don’t want to lose these units to “cheap kills.” As an example, the rocket-propelled grenade (RPG) threat has been widely-proliferated around the world. They are cheap to produce. There is little doubt that this sort of weapon could immobilize many armed unmanned systems, if not properly defended against. Fortunately, this threat has been addressed. Active protection systems, such as TROPHY<sup>3</sup> have been designed specifically with this sort of threat in-mind.

Most active protection systems share a downside: shrapnel. If there are friendly forces, or worse, unfortunate civilians, in the immediate area surrounding an active protection system-equipped vehicle, they run the risk of being hit by shrapnel from one of these systems when it reacts to an inbound threat. Consider coupling one of these active protection systems with Active Denial: Active Denial could be used to create a “no man’s land” around the vehicle, keeping people outside a particular range. This range would be driven by the danger zone posed by the shrapnel from the active protection system. In this manner, we would enable the use of one system with another.

Looking for, and taking advantage of, such synergistic system interactions for the warfighter is one that the producers of individual systems would not do. We would argue that looking for such synergistic arrangements is a fundamental government role.

There is a traditional Bushido<sup>4</sup> view of, “How do you use your sword to give life?” This use of armed autonomous systems to go after the weapons of war, instead of the human enemy, is the perfect example of how this might be embodied.

Again, it is fundamentally a governmental role to decide to pursue such an approach to a weapon system. Contractors can help to implement it, but the basic decision lies with the government.

---

<sup>2</sup> See, for example: <https://www.jnlwp.com/ads.asp>

<sup>3</sup> See for example: [http://en.wikipedia.org/wiki/TROPHY\\_Active\\_Protection\\_System](http://en.wikipedia.org/wiki/TROPHY_Active_Protection_System)

<sup>4</sup> See, for example: <http://en.wikipedia.org/wiki/Bushido>

## **Conclusion**

Armed, fully autonomous unmanned systems offer a new paradigm for the conduct of war that can lead to the rapid cessation of hostilities by disarming a foe, instead of killing him, and/or non-combatants.

The government must be fully in control of the development of such a capability to ensure that it meets international treaties and Law Of Armed Conflict considerations. Additionally, it must follow the Rules Of Engagement once on the battlefield.