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Unmanned Aerial Vehicles

U.S. Losing Critical Skills Needed To Weaponize Unmanned Systems

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By Millard S. Firebaugh

When U.S. forces went into Iraq in 2003, the military had fewer than 170 unmanned aerial systems and only a handful of ground robots. By 2008, the number of unmanned aerial systems had reached 6,358, and ground robots nearly 12,000.

Commanders clearly want armed unmanned systems. But the biggest issue facing weaponization of unmanned systems is the decline in U.S. energetics expertise. These skills are key to the future of armed robots.

So far, unmanned systems have been weaponized by retrofitting aircraft to launch munitions that already exist. For example, the Predator unmanned aerial system was fitted with two Hellfire missiles. The Shadow unmanned aerial system may be equipped to drop 81mm mortar rounds. The Reaper would be armed with up to four Hellfire missiles, two laser-guided bombs and a 500-pound smart munition.

These approaches both rely on munitions made up of yesterday's explosives and propellants, called "energetic materials." A National Academies of Sciences report noted that "using yesterday's energetic materials in today's battlefield systems would be as effective as trying to run a Ferrari on kerosene."

Energetics specialists should be involved in the development of unmanned systems and their munitions. Proof of that is the development of the M1 tank. It could outrange Iraq's Soviet-made tanks because energetics experts developed high-energy propellant grains, each the same size and including engineered holes that enabled increased combustion. Engineers designed the cannons to withstand the propellant's high pressures.

Energetics experts are needed to address both propellant and warhead issues in unmanned systems weapons. They can help reduce munitions' size and weight while ensuring effectiveness on a range of targets. They would also enable tactical concepts such as the "swarm" — multiple, small unmanned systems finding and attacking targets.

The ongoing development of the 5-pound, 25-inch long, Spike missile by the Naval Air Warfare Center is an example of what can be done. Munitions weight and volume can be reduced more with micro-electrical mechanical systems for fusing, and reactive materials, normally non-explosive solids that upon impact release extraordinary energy.

Munitions must be developed for their environment. The Hellfire missile had to be re-engineered for Predator's high altitudes, since it was originally designed for launch from helicopters flying below 2,000 feet. Similarly, munitions must be designed for unmanned systems that operate in undersea environments. Also, munitions need to be made insensitive to shock.

Energetics experts will be needed to develop munitions for the Navy's stealthy unmanned combat aircraft, which is planned for suppression and destruction of enemy air defenses and penetrating strike missions. To keep the aircraft low-observable, weapons must be developed in forms that facilitate stowage and launch from inside the aircraft.

Almost every defense system relies on energetic materials, either in the form of an explosive fill or propellant.

As Lawrence Livermore National Laboratory's Richard Behrens wrote in the January issue of this magazine: "Over the past 20 years I have worked with the Defense Department in the area of energetic material development for use in propellants and explosives ... I have observed the contraction of this S&T effort in this area, where the nation currently stands at the point of losing almost all expertise in this area due to retirements, lack of funds to hire new staff, and the inability to create an interesting and challenging S&T environment that will attract some of the brightest to this area of research."

Behrens echoed what previous studies have said about U.S. energetics. A rapid drop in research and development funding for munitions, to include explosives and propellants since the mid-1980s was reported by a 2001 Department of Commerce study, titled National Security Assessment of the High Performance Explosives and Explosive Components Industries. "If support for R&D continues to decline, the ability of the United States to provide world-class munitions in the future could be degraded," the study said.

Today, the Defense Department buys Swedish bunker-busters, German environmentally-friendly training ammunition, and it is considering buying South African artillery ammunition. Also, many precursors for U.S. propellants and explosives come from other countries.

Sources of talent are drying up, as was reported in the 2004 National Academies of Sciences study, Advanced Energetics Material. "The U.S. effort in the synthesis of energetic materials at present involves approximately 24 chemists, several of whom are approaching retirement," the study said. "If the level of effort that these scientists have contributed is not fostered and maintained, the United States will lose the technological edge that it has gained as a result of their work."

By 2006, the Naval Surface Warfare Center at Indian Head, Md., had four molecular design and chemical synthesis scientists, down from 13 in 1994. This talent is not easily replaced. It takes five to 10 years to learn military energetics. U.S. industry is not a substitute. It has little interest in long-term energetics research and development and limited interest in manufacturing energetic materials. Five major U.S. companies once manufactured propellants. Today, that number is two.
In 2008, a House Armed Services Committee report expressed concern that the investment required to adequately sustain a robust energetics research, development, and manufacturing technology program has not been maintained.

Advanced energetics materials have already been adapted for unmanned aerial vehicles. The Russian company Basalt offers the TBG-29 rocket-propelled Thermobaric warhead, which can be launched from unmanned aerial vehicles and used against troops in the open and in buildings, and lightly armored and soft skinned targets.

In recent years, the importance of energetics expertise has been eclipsed. Weapons programs have focused more on the platform than the munitions they deliver. Others have focused more on the precision of munitions than on the explosives and propellants that go into them. And, still others wrongly believe that there are no more energetics advances to be found.

If this research field is not rescued soon, critical future capabilities such as arming robots will become endangered.

Millard S. Firebaugh is a retired U.S. Navy rear admiral. He is Minta Martin Professor of Practice in the Department of Mechanical Engineering and a member of the Center for Energetic Concepts Development at the University of Maryland, College Park. He is a member of the National Academy of Engineering.

Reader Comments

Re: U.S. Losing Critical Skills Needed To Weaponize Unmanned Systems

Mr. Firebaugh has done a good job in this article and supplied very needed information to the public on an issue that is very important to this country. But one issue Mr. Firebaugh missed was the wall that unmanned aviation assets have now hit, the wall is "persistence" flight operations over the battlespace for ISR that commanders are demanding every hour of the day. What is now needed to get over this wall is aerial refueling a field I have been working in for six years and do you think our national leadership and investment dollars is on this page for such capability not even.
I have designed capabilities for aerial refueling at airspeeds not seen in over 80 years and I can't get the time of day from DOD or my Senator. What would happen if manufactures of UAS knew that there class III or IV UAS could be refueled in mid-air at airspeeds below 100 knots. Well it can be do using all off-the-shelf flight proven technologies. My email is raveneye58@gmail.com if anyone is interested.

Alan on 07/07/2009 at 09:26

Re: U.S. Losing Critical Skills Needed To Weaponize Unmanned Systems

Energetic material research, both explosives and propellants, could be defined a one of the top five strategic technologies in order of its importance to national security.

There is already discussions on nano-energetics and other types of materials that may offer 10x improvements over the current state of the art (the Defense Science Board study on Future Strategic Strike talked about 100x as powerful explosives as being possible).

A military able to weaponize explosives with this power could have incredible military advantages on the battlefield. Using the 10x's example, imagine the 250lbs JDAM with the power of the 2000lbs JDAM and then understand that the B-2 might carry 80 or more hitting 80 or more aimpoints. This is awesome firepower for a single aircraft.

Due to the time it takes to train a new energetics scientist maybe the US should consider backfilling from our NATO allies (or co-operative research)while developing long term

Due to the time it takes to train a new energetics scientist maybe the US should consider backfilling from our NATO allies (or co-operative research)while developing long term educational objectives.

bobbymike on 06/15/2009 at 14:41

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