NAVAL WAR COLLEGE
Newport, R.I.

EXTENDING OPERATIONAL REACH WITH UNMANNED SYSTEMS

by

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A paper submitted to the faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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16 May 2003

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
16-05-2003

2. REPORT TYPE
FINAL

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
EXTENDING OPERATIONAL REACH WITH UNMANNED SYSTEMS (U)

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
CAPT Rand D. LeBouvier, USN

Paper Advisor (if Any):

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Joint Military Operations Department
Naval War College
686 Cushing Road
Newport, RI 02841-1207

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Distribution Statement A: Approved for public release; Distribution is unlimited.

13. SUPPLEMENTARY NOTES A paper submitted to the faculty of the NWC in partial satisfaction of the requirements of the JMO Department. The contents of this paper reflect my own personal views and are not necessarily endorsed by the NWC or the Department of the Navy.

14. ABSTRACT
While unmanned vehicles promise a multitude of operational capabilities and might be seen as a Revolution in Military Affairs (RMA), the focus of this discussion is primarily upon understanding their most constructive applications in support of the operational commander. The relative novelty of unmanned systems offers an opportunity for warfighters to provide their input during concept development to guarantee systems accommodate their operational requirements. With caution and foresight, the ultimate potential of unmanned systems may be realized.

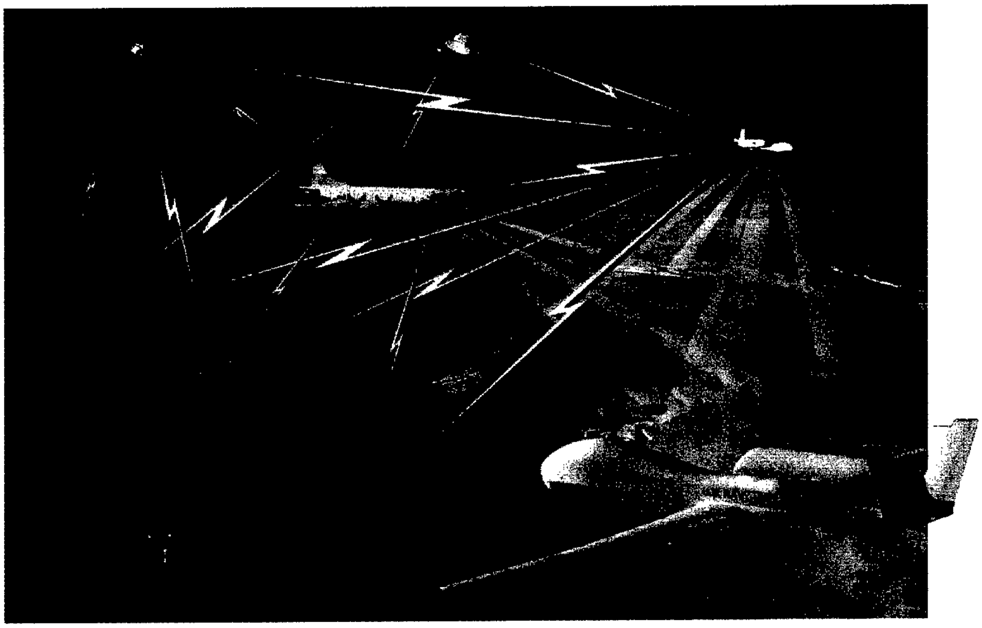
Now that we are beginning to understand their capabilities, unmanned systems are quickly becoming indispensable. It is essential to develop a commensurate understanding of the impact of this resource - particularly upon operational warfare. Perhaps the greatest contribution that unmanned vehicles can make is as an extension of operational reach as an adjunct to, not a replacement for human decision making. Unmanned systems allow the operational commander the ability to extend his reach in terms of space, time, and force. As to their proper status: unmanned vehicles are tools. How we use these tools is more relevant than the kinds of technologies they proffer. Unmanned systems are already capable of giving us more information than we require and demanding more of our attention than we can spare. The problem will be exacerbated as systems progress and proliferate.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Chairman, JMO Dept
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		24	19b. TELEPHONE NUMBER *(include area code)* 401-841-3556

Standard Form 298 (Rev. 8-98)

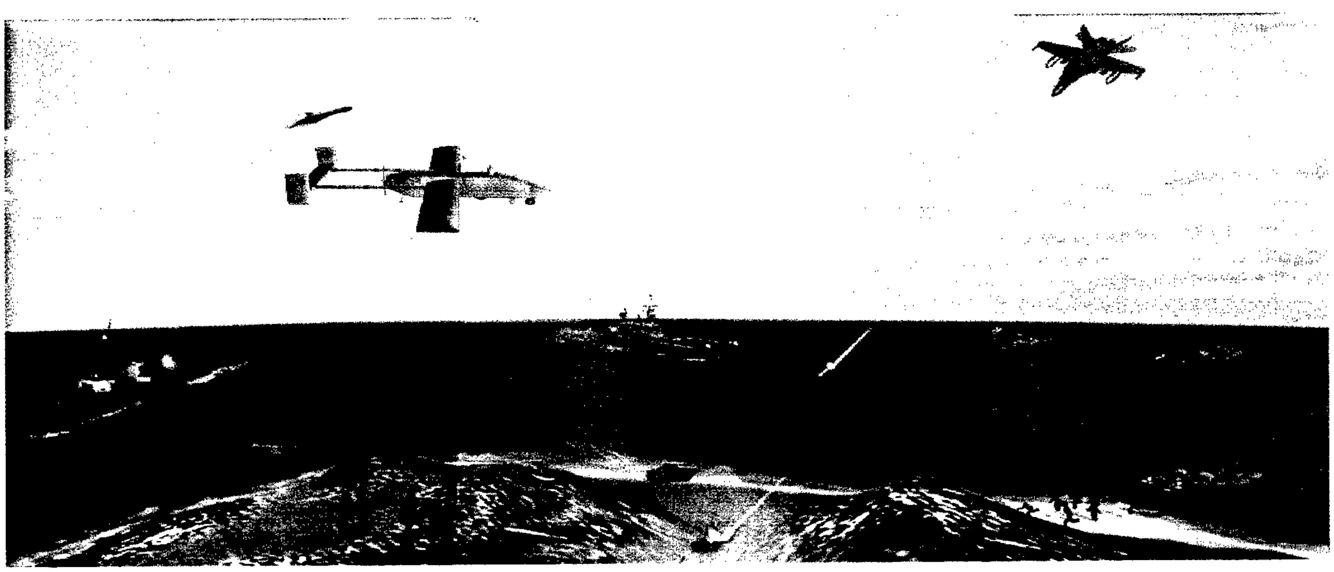
12



In this rendering, the Global Hawk Maritime Demonstration UAV, in conjunction with manned P-3 aircraft and satellites, provides imagery and information while extending the reach of both of these assets.

Acknowledgements

The assistance of the cognizant Service Unmanned Vehicle offices is greatly appreciated. Except where otherwise noted, illustrations are provided courtesy of Mr. Mike Brinck and the staff at DPA Associates who are in the process of graphically translating the Navy and Marines Corps UAV Concepts of Operations- a process to which I contributed only my limited knowledge during my tenure as Head of the Unmanned Aerial Vehicle Section in OPNAV.



The venerable Pioneer UAV providing strike support and ISR to Fleet and Marine forces

Introduction

"Surely the *great* fear is not that machinery will harm us - but that it will supplant us."

Isaac Asimov, *Robot Visions*

We are fascinated to watch as the latest generation of Unmanned Vehicles (UVs) provides us views of the battlefield while events actually unfold. This fascination has created a rapid acceptance of the role of unmanned systems in a transformed military. This is a striking occurrence, because until recently our inherent fear of being replaced by machines had limited the growth of unmanned systems. The acceptance has been so rapid that acquisition of this advanced capability has outstripped attempts at clearly defining operational roles. Now that we are beginning to understand what they can do for us, UVs are here to stay, and it is critical that we develop a commensurate understanding of the impact of this resource -- particularly upon operational warfare.

"It will not be a case of competing and replacing at all, but of intelligences together, working more efficiently than either alone within the laws of nature." Isaac Asimov, *Robot Visions*

Perhaps the greatest contribution that unmanned vehicles can make is as an extension of operational reach as an adjunct to, not a replacement for human decision making. The rules of the game are changing, and unmanned vehicles offer both convenient solutions and more complex problems that must be addressed. Unmanned systems allow the operational commander the ability to extend his reach in terms of space, time, and force. As to their proper status: unmanned vehicles are tools. How we use these tools is more relevant than the kinds of technologies they proffer.

> ...the intrinsic relationship that arises between tools and organs... is that in the tool the human continually reproduces itself. Since the organ whose utility and power is to be increased is the controlling factor, the appropriate form of a tool can be derived only from that organ.[1]

As a nineteenth century philosopher of technology, Ernst Kapp postulated that the tools we create serve best as extensions of our physical capabilities and thus should be designed with our own limitations in mind. The possibilities for unmanned systems are limited only by our imagination, but we must be cautious not to overwhelm the users of this burgeoning technology. Unmanned systems are already capable of giving us more information than we require and demanding more of our attention than we can spare. The problem will be exacerbated as systems progress and proliferate:

> In considering future society, let us assume that . . . the trend toward automation will continue. In that case the kind of work that will be done in the future will tend to be more and more that of supervision of the machinery that does the real work . . . Isaac Asimov, "Man and Computer"

While unmanned vehicles promise a multitude of operational capabilities and might be seen as a Revolution in Military Affairs (RMA), the focus of this discussion is primarily upon understanding their most constructive operational applications in cooperation with humans. This is not intended as a justification for acquisition nor is it a list of potential missions (which is already quite ponderous and getting bigger). This discussion will focus even more specifically on the proven roles of intelligence, surveillance, and reconnaissance (ISR), and precision strike where the impact on operations has already been most appreciable.

Background

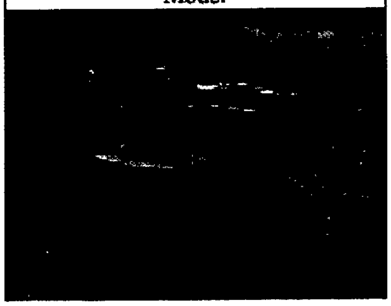
The realm of unmanned vehicles now includes Unmanned Aerial Vehicles (UAVs), Unmanned Combat Air Vehicles (UCAVs), Unmanned Underwater Vehicles (UUVs), Unmanned Surface Vessels (USVs), and Unmanned Ground Vehicles (UGVs). Within each of these categories UVs can be further divided into sub-categories according to size, endurance, capability, operating environment, and other characteristics. While the Air Force leads the way in UAV development and procurement, the Army, Navy, Marine Corps, and Coast Guard are now on the fast track. The Department of the Navy is the single department with interests in all types of unmanned vehicles due to its operation in all environments.

The Office of the Secretary of Defense (OSD) has released an Unmanned Aerial Vehicle Roadmap, the Navy and Marine Corps have jointly released a Naval UAV Strategy and a Roadmap, the Army and Air Force have developed their own UAV roadmaps, and the Coast Guard has included unmanned vehicles in its Deepwater program. In response to Congressional interest, significant pressure, and requests for information, the services have come together in an unprecedented fashion to address this key transformational piece. These initial efforts are primarily acquisition-oriented while operational concepts are still in their inception. The services are currently meeting to exchange Concepts of Operations (CONOPS) to ensure their efforts are complementary, not duplicative.

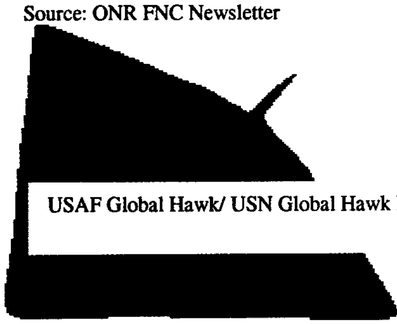
The relative novelty of unmanned systems (they have actually been with us a while but are just now keeping our attention) offers an opportunity for warfighters to provide their input during concept development to guarantee systems are designed to accommodate them as the end users. The most reasonable approach, and one that seems to be obtaining greater acceptance among those in the field, is for all unmanned systems to have as many common features as possible. In the future, virtually the only thing that would distinguish the vehicles apart is their method of accessing the environment in which they operate. Sensors, communication links, control stations, and special payloads could be shared through a "plug and play" architecture. To the end user -- in this case the operational commander -- the product would be information. Whether that information came from a UAV or a UGV would be transparent.

With that short primer on unmanned systems, the discussion may advance to show how unmanned vehicles can provide the operational commander with a tool that can allow him to observe and influence operations as never before. For those who feel that "technology is necessary, but dangerous,"[2] perhaps that is wiser in this instance than it is paranoid. With every tool comes the responsibility to understand how to properly wield it. With caution and foresight, the ultimate potential of unmanned systems may be realized.

Gladiator Tactical UGV Concept Model

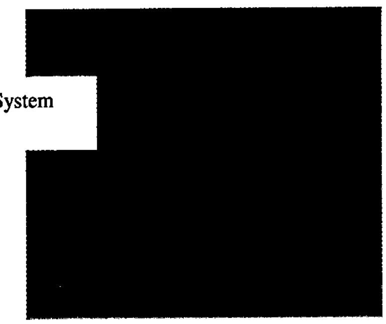


Source: ONR FNC Newsletter



USAF Global Hawk/ USN Global Hawk Maritime Demonstration System

Artist's rendering of strike-capable Unmanned Combat Air Vehicle (UCAV)



Artist's rendering of Broad Area Maritime Surveillance System (BAMS) UAV

Analysis

Advocates of UV's rely heavily on the justification that they are best applied in situations where it is "dull" (long dwell, routine, repetitive), "dirty" (contaminated environment) or "dangerous" (within an enemy's engagement envelope) -- rather tritely referred to as the 3 D's. While this hackneyed phrase does serve to indicate the primary rationale for unmanned systems, it only touches on their potential. Properly applied, unmanned systems may provide advantages in many situations. Prohibitive cost has to a large degree prevented wider application to date. Broadened to address an extension of operational reach, the 3 D concept is useful in initiating an understanding of how the operational factors of space, time, and force are affected by unmanned systems.

Extending the Battlespace with Unmanned Systems; the Operational Factor of Space

In terms of the "dirty" and "dangerous," Unmanned Vehicles can operate in areas where manned vehicles and troops could not or should not operate, functioning as "extended reach as an adjunct to manned platforms, providing assured access to denied/unsafe areas of operations."[3] They effectively extend the battlespace that an operational commander can influence. Not only do they allow virtual access for friendly forces, unmanned systems can be used to deny sanctuaries[4] to the enemy through presence and vantage point. In austere environments that are not necessarily "dangerous" but are difficult places in which to operate, unmanned systems are proving to be very adaptable.[5]

When sufficient systems are available, they may be deployed in netted groups or even swarms that would allow the operational commander to effectively keep the pressure on the enemy "everywhere."[6] The resultant effect on the enemy of having to keep his head down, being unable to mass his forces for attack, and being constantly on the run would be debilitating and exhausting. Though no official reports have yet been released for Operation Iraqi Freedom, such an effect appears to have been achieved by the operational commander. Unmanned systems also function well in a stand-off capacity, distracting the enemy from manned platforms and troops and approaching from directions that are unexpected.

Extending Persistence with Unmanned Systems; the Operational Factor of Time

In terms of the "dull," the services quickly realized that persistence is one of the most desirable features of unmanned systems. Even now UAVs are available that can provide significant loiter time (days instead of hours) in an operating area. Future UAVs may be capable of loitering for months or even longer. UGVs and UUVs could be made to lie dormant in passive mode for extended periods of time.[7] This ensures the unrelenting (even covert) presence of mobile sensors when needed.

Having a persistent view of the battlespace provides the operational commander with excellent situational awareness, allowing him to observe trends and patterns. Knowing how the enemy is arrayed and deployed eliminates some of the uncertainty of operations, and in the Afghanistan conflict (for example) it, "allowed ground forces to maintain a faster pace of operations when they moved in -- a key advantage in keeping an adversary off balance."[8]

There is no dispute that unmanned systems can perform some functions more rapidly than their manned counterparts. This, in turn, allows rapid decision-making, "providing the commander a capability to gather near-real-time data on opposing force position, composition, and state of readiness."[9] Further, logic supports that the combination of sensor and shooter in one package decreases time required to engage "dynamic execution targets."[10] The re-tasking of manned aircraft can be a time-consuming and often confusing proposition, while, "The UAV is ideally suited for immediate missions that were not previously anticipated because of rapidly changing tactical situations."[11]

Extending Capability with Unmanned Systems; the Operational Factor of Force

Obviously, the major attraction of unmanned vehicles is that they avoid risk to personnel. Apart from the 3 D's, unmanned systems operating in conjunction with manned assets act as, "force multipliers, operating autonomously in theater for extended periods."[12] UVs in theater can reduce the operational commander's dependence on national assets for intelligence and imagery. Unmanned systems can be developed to operate more autonomously than ever before. But, this autonomy has a cost, both monetarily and in terms of operational effects, which will be discussed later.

Widespread, persistent UVs can reduce the possibility of surprise against friendly forces while increasing their covertness. Human scouts could use UVs to augment their range of observation in all dimensions while remaining in relative safety. Sniper platforms controlled by human counterparts would be neither distracted nor discomfited by their surroundings. Because of the lack of risk to personnel, UVs are presumed to be ideal for "kick-down-the-door" type operations.[13]

The situational awareness provided by unmanned systems allows the operational commander the ability to place the right forces where and when needed to strike decisively. He is therefore able to keep the enemy off balance. The operational commander can more precisely apply weapons effects in this manner.[14] Even without weapons, UVs can be applied to create desired military effects through mere presence. Excellent evidence of this is provided by the Iraqi forces who surrendered to an unarmed Pioneer UAV during the first Iraq conflict (this UAV is now enshrined in the Smithsonian Air and Space Museum).

Through coordinated and skillful placement of unmanned systems and interpretation of the information they provide, UVs can be used for preparation of the battlespace and as battlespace management tools to provide situational awareness. To exploit this capability, interaction among UV operators, intelligence specialists, and operations personnel will have to be more closely coordinated than ever before -- a key point for the operational commander to comprehend as he organizes his staff.

Space-Time-Force Considerations

Each of the discussed major effects of UVs on Space, Time and Force has been compiled in the following table. By connecting the columns in various logical combinations of space, time and force, one can demonstrate a cumulative effect that is more than the sum of each individual effect. For example, in an ISR role, a high altitude, long endurance (space-time) UAV can assist in maintaining situational awareness (force). It also allows the bonus of reduced demand on manned assets in terms of presence, on-station time and fatigue (space-time-force). In a strike/strike support role, a UCAV can access areas denied by enemy air defenses (space); its onboard weapons systems allow faster sensor-to-shooter dynamic execution (time), applying precision effects against difficult targets (force). The cumulative effect is the availability of an on-station, on-call platform that poses less risk to manned strike aircraft and crews (space-time-force). As an extra bonus, the UCAV can provide its own Battle Damage Assessment (BDA).

SPACE	TIME	FORCE
extend the battlespace	provide significant loiter time	act as force multipliers
allow virtual access	maintain unrelenting presence of sensors	reduce dependence on national assets
deny sanctuaries to the enemy	Observe trends and patterns	reduce possibility of surprise

adapt to austere environments	eliminate some of the uncertainty	allow you to put right forces where and when you need them
effectively keep the pressure on the enemy "everywhere"	decrease time to engage dynamic execution targets	keep the enemy off balance
stand-off	are ideally suited for immediate missions	allow application of precision effects
	perform some functions more rapidly than their manned counterparts	act as enablers for preparation of the battlespace and maintenance of situational awareness
	provide near-real-time data	are ideal for "kick-down-the-door" ops
	allow ground forces a faster pace of operations	can create desired military effects through presence

Unmanned Systems Effects on Space, Time and Force

Carefully Wielded, a Tool for the Operational Commander

> Terrorism thrives on the element of surprise and one of the key ways to defeat it is to take the fight to the terrorist. We must be able to deal with threats at distance: hit the enemy hard in his own backyard – not in ours – and at a time of our choosing not his.
> We must be able to get the right forces quickly to where we need them, make better use of intelligence to identify the threat, decide how to deal with it, and then strike decisively.[15]

This statement by Defence Secretary Hoon of the United Kingdom provides a concise impetus for correctly defining the UV operational concept. UVs can provide the kind of capability that seems to be tailor-made for combating the threat of terrorism, as well as for remaining dominant in traditional combat operations. Through presence, persistence, and capability, UVs can severely diminish the ability of an enemy to remain unseen and unheard. While this appears to be an ideal match of tool to task, there are some "safety precautions" that must be read beforehand:

> Army Maj. Gen Franklin L. "Buster" Hagenback, the commander of regular U.S. ground forces in Afghanistan, said in an interview that from his perspective, the biggest problem caused by the Predator [UAV] was that its transmission of real-time images made staffs above his own division's staff feel they were in a position to get involved in the battle.[16]

While UVs may seem to be a panacea for all informational and access-related deficiencies, caution is recommended at the operational level. The images which are now part of our daily lives and available to the media can have an undesirable effect on our perception. The video can be misleading or even have a hypnotic effect on the untrained eye. The more this type of instant gratification is available, the more the desire for real-time imagery increases. This can distract the operational commander or his staff from the bigger operational picture: "The danger is, you get too focused on what you can see and neglect what you can't see."[17] This is a corollary to what has been called the "Soda-Straw" effect -- the restricted field of view caused by UV optical imager limitations. Even if a target of interest is located, the Soda-Straw effect is multiplied by the natural inclination to focus on that target and to forget about what is happening elsewhere in the battlespace. To properly comprehend and control the flow of operations, what happens elsewhere is most often more important.[18]

Perhaps more worrisome than distraction, the ability to observe the battlespace in detail increases the potential for high level micromanagement. In lessons learned from Afghanistan, it was found that "live video links gave . . . little useful information and were sometimes a distraction, encouraging higher-level military staffs to try to micromanage the fighting."[19] This begs the question as to what imagery and information is important for the operational commander and his staff to see and what imagery and information should be deliberately compartmented or sanitized to prevent information overload and to resist the impulse of an operational commander to give rudder orders to UV operators.

One of the selling points for UVs has been that they will reduce the manpower and workload required for manned platforms and staffs. This has not yet been achieved, and in fact, "the time troops must spend monitoring their robotic systems and payloads often adds to their duties rather than easing them."[20] As mentioned earlier in this discussion, true autonomy is not without its own costs. Most likely the currently exorbitant costs of autonomous functions will decrease as technology advances. Still, we may not be ready either operationally or emotionally to allow UVs to roam freely throughout the battlespace, independent of human intervention, no matter how well we pre-program them. As it stands, the most advantageous relationship for the near future may be one of symbiosis or perhaps a kind of man-machine hybrid.

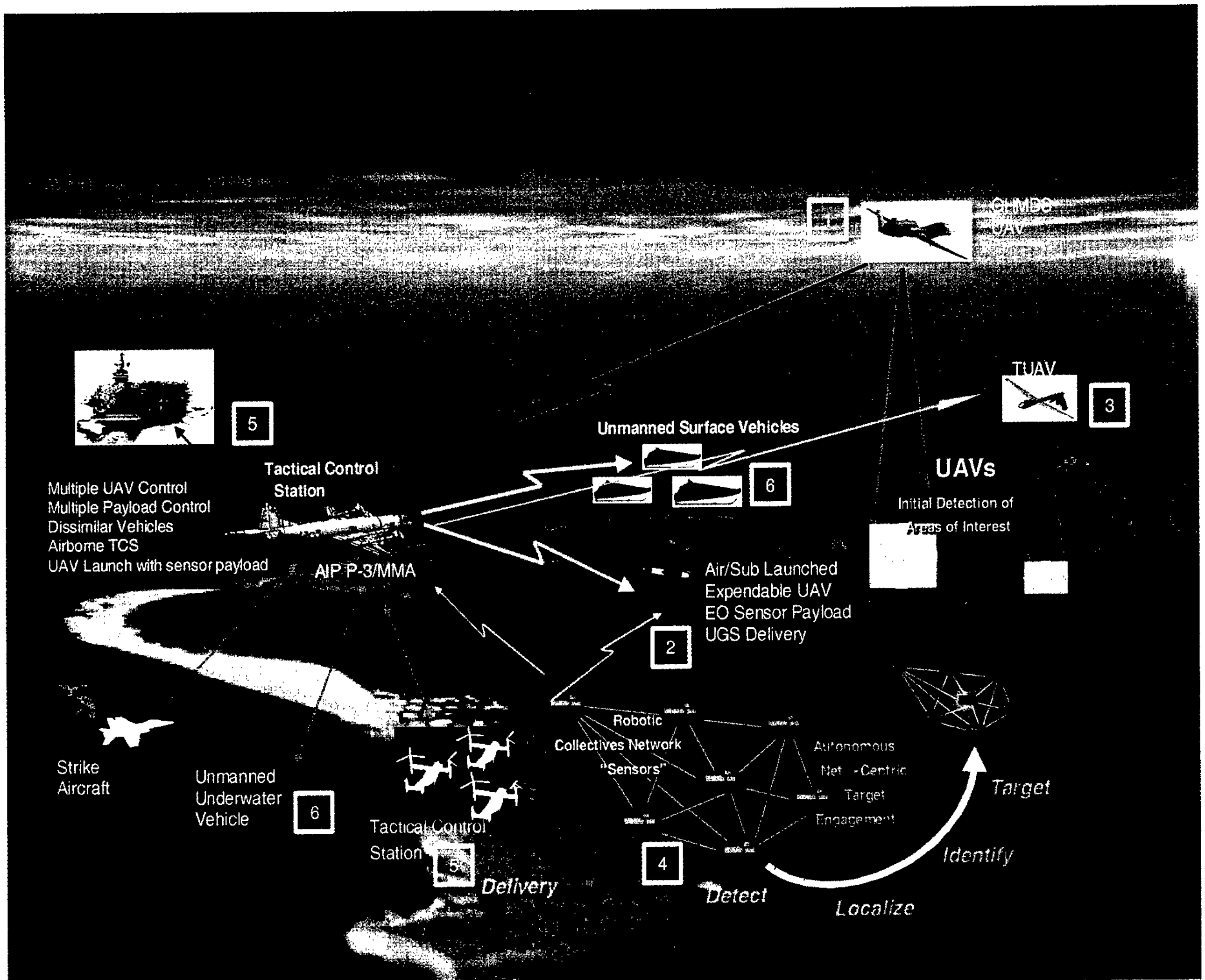
As precision strike platforms, UVs may be the ideal sensor-shooter fusion for successful prosecution of targets of opportunity. This entails a rapid reduction of decision times for engagement, and we must decide how much of the commander's own authority we wish to abrogate. Essentially, "It means the rules of engagement have changed."[21] This is a key consideration for the operational commander, especially as weaponized UVs are already a reality:

"UAV units are only designed to support a single command or component. When UAV units are tasked to support more than one command or Service component simultaneously, degradation of effectiveness can result."[22]

This statement reveals a limitation of UVs in an operational context. There has been a great deal of discussion about shifting control of UVs from one organization to another based on the situation. Does the operational commander need to control the sensors and the platform? While this is certainly feasible, the advisability or necessity remains to be proven. The rationale to support transfer of control has been that to properly exploit the sensor, one must control the platform. The ability to control the sensors and the platforms may be a reasonable expectation of an operational commander who might view an asset like the high-flying, wide perspective Global Hawk UAV as his personal low-hanging satellite. Like any other ISR asset though, the driving is best left to the vehicle operator and the imagery interpretation is best left to those trained to do it. The desires of the operational commander can be promptly translated and communicated to them. While instant gratification may not be had, it is perhaps a more logical way to prevent the kind of myopia and micromanagement mentioned earlier.

In a more positive vein, in certain situations, theater commanders would immediately benefit from the kinds of capability already resident in unmanned vehicles. The combatant commanders to target are those who have a routine task of containing or deterring a long-standing, active threat. Commander, Northern Command, Commande,r U.S. Forces Korea and Commander, U.S. Southern Command may be at the forefront of those commanders. Commander, Northern Command, in cooperation with other agencies, will bear a significant burden for Homeland Defense and will be required to continuously monitor a vast area against the possibility of terrorist attack, Weapons of Mass Destruction smuggling, and illegal penetration of air and sea space. Commander, U.S. Forces Korea has had to monitor a relatively small area of interest for over fifty years; unmanned systems would allow him to do this more efficiently and effectively while observing trends and indicators that could warn of impending hostilities from North Korea. In the campaign against narcotics, the Commander, U.S. Southern Command has used unmanned airships in the past and would be able to significantly expand his ability to observe and interdict the drug trade through the use of airborne, seaborne, and terrestrial robotic sensors that cannot be bribed or intimidated.

Unmanned systems can provide both solutions and problems. The solutions are exciting. The problems, if not addressed early enough, could seriously degrade the usefulness of UVs as tools. As we progress down this promising path, we will have to adapt this tool to our own human capabilities and limitations.



[23]Source: ONR Presentation

In this rendering of a concept to be tested in Fleet Battle Experiment Mike from an Office of Naval Research presentation, netted UV's cooperate to provide a complete, real-time and persistent view of the battlespace.

The CONOPS depicts:

1. The Global Hawk Maritime Demonstration System (GHMDS) UAV identifying Areas of Interest
2. An Expendable UAV extending P-3 surveillance range
3. A Tactical UAV (TUAV) conducting a Reconnaissance, Surveillance, and Target Acquisition (RSTA) mission
4. UGVs/Robotic sensors detecting, localizing, and identifying land target threats
5. Tactical Control System (TCS) interfacing UVs to Command, Control, Communications, Computers and Intelligence (C4I) systems
6. Unmanned Underwater Vehicles/Unmanned Surface Vessels interfacing to C4I systems via TCS

Recommendations

Keep them simple

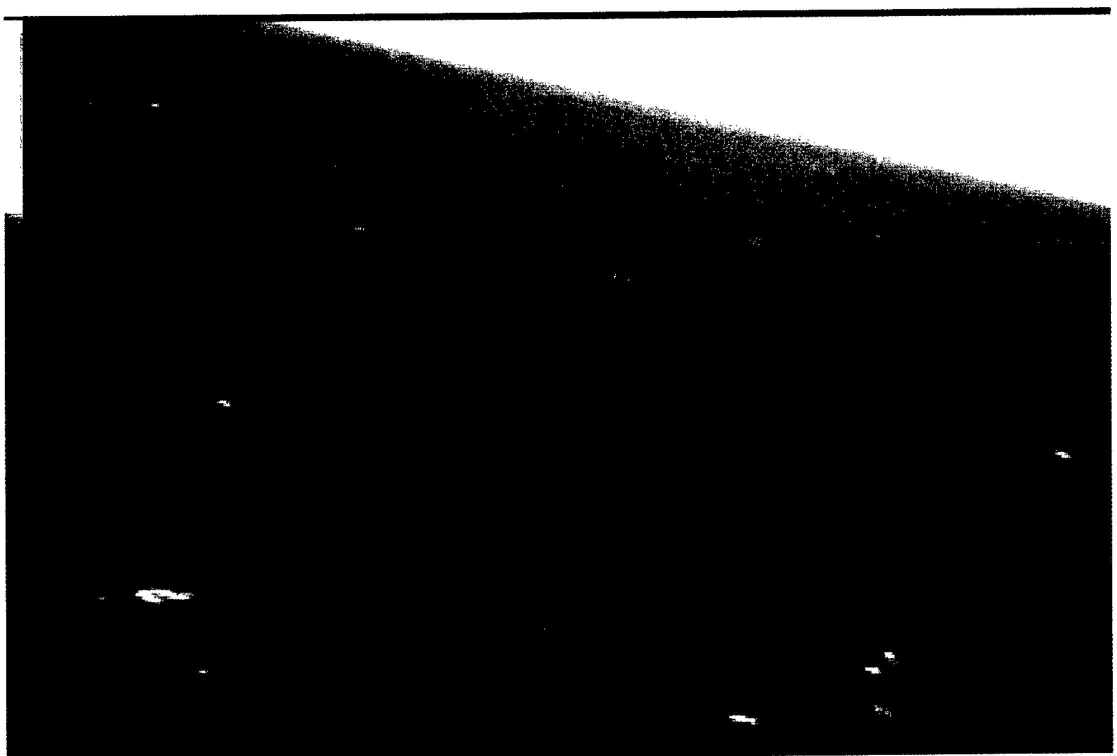
Unmanned systems are not generally cheap and easy tools to build. That means that we must exercise care as we invest our financial resources, time, and talent to develop them. Having seen what kind of operational effects may be achieved with UVs, one can understand the tendency to try to build them as "Swiss Army knives" -- the quintessential all-in-one tool. That approach would have exactly the opposite result in that UVs would become too valuable to put at risk. The recommended approach is to keep the systems simple, particularly at the end user level.

Keep them cheap and easy to use

Lessons learned from Afghanistan indicate that concern over losing a high demand, low density, expensive asset like the Global Hawk UAV caused the operational commander and his superiors to pause before using it. That concern should not be a consideration to the operational commander. Currently, systems like Global Hawk require control stations and monitoring personnel in a configuration that resembles NASA Mission Control. Much is already being done to reduce the scale of the effort required to operate and exploit these systems, but the combatant commanders as the primary operational commanders involved, should keep the pressure on to ensure that we do not buy tools we are either unable or unwilling to use.

Keep the human in the loop

Until true artificial intelligence is achieved and we become confident in its reliable application, unmanned systems should be pursued as an extension of operational reach in conjunction with human decision making. One hurdle that unmanned systems will probably never clear is the fact that there is no substitute for the human ability to draw conclusions from input received from all five human senses. Call it instinct or operational art, it is a fusion that cannot readily be duplicated or even quantitatively described. For the foreseeable future, we can and should develop unmanned systems to complement our human abilities. The tool should fit our hands.



Still frame from very entertaining video concept of a UCAV approaching CVN for landing. Source: Northrop-Grumman

LIST OF ABBREVIATIONS AND ACRONYMS

BAMS - Broad Area Maritime Surveillance System UAV

CONOPS - Concept of Operations

C4I - Command, Control, Communications, Computers and Intelligence

GHMDS - Global Hawk Maritime Demonstration System

ISR - Intelligence, Surveillance, and Reconnaissance

NASA - National Aeronautics and Space Administration

OSD - Office of the Secretary of Defense

RMA - Revolution in Military Affairs

TCS - Tactical Control System

TUAV - Tactical UAV

UAV - Unmanned Aerial Vehicle

UCAV - Unmanned Combat Air Vehicle

UGV - Unmanned Ground Vehicle

USV - Unmanned Surface Vessel

UUV - Unmanned Underwater Vehicles

UV - Unmanned Vehicle

XUAV - Expendable UAV

3 D's - Dull, Dirty, and Dangerous

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ENDNOTES

[1]Ernst Kapp, quoted in Carl Mitcham, *Thinking through Technology; the Path between Engineering andPhilosophy* (Chicago: Chicago University Press, 1994), 23-24.

[2]Mitcham, 277.

[3]Kathryn Shaw and Nick Brown, "Unmanned Vehicles Enter the Underwater Battlespace," *Jane's Navy International*, December 2002, Feature article.

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