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# UAV Technologies and Combat Operations

## Executive Summary

### Introduction

The Air Force has entered a new era, an era in which the unmanned aerial vehicle (UAV) has become not only acceptable, but desirable, for long-endurance reconnaissance missions. It is timely then, for the Air Force Scientific Advisory Board (SAB) to review technology maturity in the context of accepted Air Force mission tasks and to project new UAV mission tasks—both combat and noncombat—that might be enabled by available and forecast technologies. Thus, the Air Force Chief of Staff directed the 1996 study “UAV Technologies and Combat Operations.”

The study report includes a Summary Volume (Volume I) and a Volume that includes the individual Panel reports (Volume II). The Summary Volume deals first with the mission task concepts, then the platform considerations that bound the air vehicle parameters, then the system/sub-system elements (i.e., mission systems and weapons), and finally, the human factors considerations. An example point design—a Suppression of Enemy Air Defenses (SEAD) UAV with a roadmap for programmatic accomplishment—is provided along with a recommendation that a SEAD demonstration program be pursued. Some special subjects are presented, followed by overall recommendations and concluding remarks. The reader is referred to Volume II to more completely understand the approach and deliberations in the specific areas, and to discern a more complete set of conclusions and recommendations. Additionally, some issues for which complete study was beyond the scope of, or time available in this study are also presented in Volume II.

### Findings

The study group identified a number of findings relative to the application of UAVs to Air Force roles and missions:

1. *UAVs have significant potential to enhance the ability of the Air Force to project combat power in the air war.*
2. *UAVs have the ability (range, persistence, survivability, and altitude) to provide significant surveillance and observation data economically, compared with current manned aircraft approaches.*
3. *UAVs have the potential to accomplish tasks that are now, for either survivability or other reasons, difficult for manned aircraft including counterair (cratering runways and attacking aircraft shelters), destroying or functionally killing chemical warfare/biological warfare (CW/BW) manufacturing and storage facilities, and suppression of enemy air defenses.*

4. *UAVs can be weaponized in the near-term<sup>1</sup> (perhaps using advanced versions of the Tier vehicles), using an existing weapon and hypervelocity kinetic energy penetrators with a family of warheads.*
5. *Insufficient emphasis has been placed on human systems issues. Particularly deficient are applications of systematic approaches to allocating functions between humans and automation, and the application of human factors principles in system design.*
6. *Most other technologies necessary for platforms, propulsion, avionics, and mission systems are sufficiently mature to provide initial UAV capabilities of the nature described above. Further technology development can significantly enhance these capabilities.*
7. *New warhead technologies—namely intermetallic high temperature self-propagating synthesis reaction incendiary and “flying plate” concepts—can provide the UAV the ability to deliver compact weapons capable of inflicting devastating damage to a large number of fixed and moving targets.*
8. *Little thought has been given to appropriate responses to enemy use of UAVs, particularly those armed with air-to-air missiles.*

In order to fully exploit the potential of UAVs, the Air Force must think of them as new and complete systems with new combinations of advantages and disadvantages, rather than as vehicles with a single outstanding characteristic or as a slight variant of an existing vehicle. Thus, advances must be made across the board, including concepts of operation, platform, weapon, mission systems technologies, and especially, human systems.

### **Operational Mission and Mission Task Concepts**

The study group assessed UAV contributions to Air Force missions and promulgated 22 missions/tasks to which UAVs can contribute. The following nine missions are representative of UAV mission needs and serve as a context in which to address technology opportunities. In no particular order, they are:

- Counter Weapons of Mass Destruction
- Theater Missile Defense—Ballistic Missiles/ Cruise Missiles
- Fixed Target Attack
- Moving Target Attack
- Jamming
- Suppression of Enemy Air Defenses
- Intelligence, Surveillance, and Reconnaissance
- Communications/Navigation Support
- Air-to-Air

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<sup>1</sup> The study group adopted the use of near-term (1996-2005), mid-term (2005-2015), and far-term (2015-2025) as the periods in which initial operational demonstrations could occur.

The study analyzed each of these missions in terms of operational capability and ability to exploit the enabling technologies. Platforms, propulsion, mission systems, and weapons were considered, as were human factors aspects. Challenges were identified and programs were suggested. The Air Force is encouraged to consider these and other missions in more detail and to establish programs in those that, after further analysis, are determined to be appropriate.

The Air Force should also be on a continual lookout for new or non-traditional missions, some of which may complement existing roles (e.g., use of UAVs as the “eyes” for B-52s, thus averting costly B-52 upgrades) and new missions that may leverage technology advances (e.g., seeding and monitoring unattended ground sensors).

## **Demonstrations**

The introduction of UAVs into the Air Force operational and organizational structure is considered an evolutionary process, highly dependent on a series of operational demonstrations of which the current Predator, DarkStar, and Global Hawk programs are part. These demonstrations are key to developing technical and operational confidence in UAVs. Specifically, the Air Force has the opportunity for *near-term demonstrations* in the following mission/task areas:

- 1. Enhanced ISR missions with electronic support measures (ESM), foliage penetration, and advanced radar sensors, coupled with automatic target cueing or screening, and advanced fusion concepts,*
- 2. ESM and jamming payloads for detection, precision location, and neutralization of radio frequency emitting threats,*
- 3. Fixed and moving target attack using UAVs to detect and locate targets based on image-coordinate transformation, cueing, and advanced lightweight weapons,*
- 4. Communications and navigation support, based on the Defense Advanced Research Projects Agency (DARPA) UAV Communications Node concept, but adding Global Positioning System (GPS) augmentation pseudolites for precision guidance under GPS jamming,*
- 5. Suppression of enemy air defenses.*

## **Recommendations**

The study Panel made numerous detailed recommendations which are found in Volume II. The major recommendations are outlined below, with more detail on each provided in Chapter 11 of this Volume.

- 1. Take the lead role in programs to exploit the near-term UAVs (Predator, DarkStar, and Global Hawk) in Air Force, Joint and National roles.*

2. *Pursue the SEAD mission as an early application of UAVs in an attack role.*
3. *Initiate a program, perhaps with DARPA, that leads to the development and deployment of advanced penetrating combat UAVs in the mid- to far-term.*
4. *Increase emphasis on effective techniques for flight management and employment of UAVs.*
5. *Establish UAV experimental capabilities to address crew-vehicle flight management concepts and increase emphasis on human system related topics in development programs.*
6. *Expand work in engines, air vehicle structures, and flight management technologies.*
7. *Supplement avionics and mission systems technology base programs in mission system automation, miniaturization, and sensor aperture areas critical to UAV operations.*
8. *Initiate a modular weapons and warhead program specifically oriented to the mission tasks most suited to UAVs.*
9. *Initiate a broad program to address opportunities for dramatically reducing operations and support costs for UAVs.*
10. *Promote command, control, communications, and intelligence (C<sup>3</sup>I) architectures that consider UAVs in the context of the overall Joint Forces structure.*
11. *Develop systems, concepts, and processes for UAV airspace management and deconfliction.*