Chapter 2

General Discussion

The study group adopted the term "unmanned aerial vehicle" (UAV) to describe the realm of unmanned aircraft. UAVs can be air vehicles specifically designed to operate without an onboard operator (e.g., Global Hawk) or aircraft intended to be manned that have been converted to unmanned operation (e.g., unmanned F-16). They can act in surveillance/reconnaissance roles, attack roles, or other support (jamming, for example) mission tasks. For the purposes of this study, cruise missiles and drones were not considered as UAVs, although UAVs could perform their missions.

The time for UAV acceptance appears to be here for a number of reasons. First, the declining force structure, people, and equipment necessitates innovative thinking about solutions that more cost-effectively accomplish Air Force missions. Secondly, technologies have emerged and matured as very significant enablers for unmanned missions (GPS for example). Thirdly, operations and support budgets are limited and there are opportunities for UAVs to provide lower operating cost and increased sortie rates. Fourth, among other attributes, the extreme endurance and potential for high flight altitude of UAVs could bring a new dimension to Air Force operations. And finally, the Air Force senior leadership is actively interested in the unmanned aerial vehicle. It remains up to the development and operational communities to cooperate in demonstration efforts that establish the viability of the UAV.

The purpose of this study was to assess system concepts as well as technologies in platforms, mission systems, weapons, and human factors as they might pertain to the accomplishment of relevant Air Force operational tasks. These assessments should help the Air Force better invest in UAV technologies and systems for the future.

The study recognizes that UAVs are not a panacea; some missions can benefit by the use of UAVs but others are better left to manned aircraft. It is important that the Air Force make the determination as to the manned versus unmanned mix. The study group, on the other hand, recognizes the important technical and operational attributes of UAVs and the functional impacts of their use as a complement to manned aircraft (see Table 2-1).

The decision to field UAVs and whether to augment or replace manned aircraft must be made after careful consideration of many factors:

- The scenarios to be encountered
- The missions and tasks
- The alternatives
- The relative risks
- The relative costs of the tasks
- The maturity of the technologies

The determination of the manned-unmanned force mix was beyond the scope of this study. In the opinion of the study group, the force mix issue can be addressed only after demonstrations (Advanced Concept Technology Demonstrations [ACTDs] for example) of operational capability and utility, and the associated formulation of operational concepts. It should be stressed that the force mix decision process is especially complex for unmanned vehicles because the introduction of such radically new weapon systems carries a great deal of uncertainty about capability, and because the methodology and models to address such complexities are not yet in place.

Table 2-1. *Major Attributes of UAVs*

Attribute	***Functional Impacts***
Endurance/Presence	• Persistent Surveillance • Continuous Deterrence • Reduced Aircraft-per-Orbit Quantities Required • Reduced Crew Fatigue • Broad, Distributed Communications Relay • Self-Deployable From CONUS; Can Operate From CONUS • Reduced Cost of Coverage
Unmanned	• Perform High Attrition Combat Tasks • Carry Weapons (With Fratricidal Possibilities) • Operate in Contaminated Environments • Operate in Provocative Role, Drawing Fire • Potentially Simpler: Reduced Cost • Reduced Crew Fatigue Problem • Less Thorough Safety Testing Required • Potential Kamikaze Employment • Reduced Cost of Coverage • Less Reasoning Power Than Manned Aircraft • Greater Need For Command & Control Tether • Crew-Saves (Aircraft & Mission) More Difficult, Less Likely
Automated	• Simpler, Less Costly Training • No Crew Safety Testing • Control Interface Simpler Than Remotely Piloted Aircraft • Less Stressing to Crews • Reduced Cost of Coverage • Reduced Physical Requirements for Operators • Crew-Saves (Aircraft & Mission) More Difficult, Less Likely
Distributed & Proliferated	• Quick Response Within Zone of Coverage • Behind-the-Lines Operation • Combined Attack (Multiple Weapons) • Broad Area Coverage With Multiple Sensors • Persistent Surveillance • Reduced System Vulnerability
High Altitude Operation	• Survivable • Performance Enhancements • Broad Area Coverage • Reduced Cost of Coverage • Better Viewing Angle For Enhanced Target Doppler, RCS • Advantageous Geometry For TBM Intercept
Low Altitude Operation	• Loss Affordable • Operate at Short Range (Smaller Weapons, Jammers, Radars)

The concept of weaponizing UAVs may seem radical or risky but closer examination of the evidence suggests otherwise. Other nations are currently weaponizing their own UAVs and the US has taken similar steps with drones and cruise missiles. The Israelis, for example, have been particularly successful in the development and operation of UAVs. Furthermore, it appears that UAV platform, sensor, and weapons technologies have matured sufficiently to permit low risk, rapid, and low-cost development and application of weaponized UAVs. The operational risk, on the other hand, is considerable, for the integration of UAVs with manned aircraft into the operational architecture is a major step in the near-term.

Though the individual technologies are relatively mature in most cases, the development of UAVs is certainly lagging. In fact, the key technologies that could and should be applied to the development of unmanned aerial vehicles are depicted in three timeframes in Table 2-2.

Table 2-2. *Technologies for Advanced UAVs*

Technology	***Past***	***Present***	***Future***
Affordability	Marginal	Design to Cost Implemented	Low Life Cycle Cost Realized
Data Links	Analog/Low Bandwidth	Digital, High Cost for Bandwidth	Standardized for USAF Architecture, Modular, Affordable
Engines	Whatever Available	Off-the-Shelf Commercial	Designed for UAVs, More Fuel Efficient
Human Systems	Automate What Was Technically Feasible; Human Filled the Gaps	Inconsistent Function Allocation; Minimum Attention to Human Factors	Simulation-based Design for Systems Relevant to Human
Low Observables	None	Current Technology: Some Penalties Perceived Costly	Lower Penalties, Lower Signatures, Lower Cost
Mission Planning	Little Automation	Some Automation, Slow, Inflexible	Automated, Flexible, Fast, Utilizing Parallel Computers
Onboard Processors	Limited Capability	Good Capability at Reasonable Cost	Excellent Performance/Low Cost
Producibility	Not Emphasized	Major Advances, Low Cost Tools for Composites	Designed for Low Rate, Low Cost Production
Sensors	Heavy, Bulky, Marginal Reliability	Major Improvements	Modular, Lightweight, UAV-Tailored
System Design Integration	Modified Manned Aircraft Techniques	Design Automation System Simulation	Integrated Design/ Simulation/ Manufacturing Automation
System Reliability	Marginal	Better, but not Acceptable	Robust Systems, Very Low Failure Rate
Training	Reliance on Prior Experience and OJT	Delegated to Contractors; Military Training Evolving	Crew Selected and Trained Using Modern Methods
Vehicle Management Systems	Off-the-Shelf, No Integration, No Automation	Some Integration, Rudimentary Automation	Optimized for UAVs: Performance, Weight, Cost, Automation
Vehicle Structure	Manned A/C Metal Approach, Large Parts Counts	Composites Not Fully Exploited, Reduced Part Count	Tailored Composite Structure, Very Low Part Count, High Fuel Fraction
Weapons	None	Little Consideration	Small, Modular, Integrated System Design

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