Unmanned Aircraft Systems
Challenges for Safely Operating in the National Airspace System
During the past 100+ years of aviation history, several innovations have greatly advanced the progress of aviation. These innovations include radar, the jet engine, and the Global Positioning System (GPS). All have served as the catalyst for major expansion for the aviation community. Another technological development may enter commercial aviation from the Department of Defense (DoD), the Unmanned Aircraft System (UAS), which raises yet-unanswered questions about its ability to safely operate with other aircraft in the National Airspace System.

UAS, also known as a Remotely Piloted Aircraft (RPA), Pilotless Aircraft or an unmanned aerial vehicle (UAV), is the name applied to both the aerial vehicle (“aircraft”) and the supporting ground system. The supporting ground system includes the pilot at a control station or device and, the command and control communications system which may employ a wide range of terrestrial and or orbital elements. More than one control station, and pilot, may be involved in a particular mission of long duration or distance.

There are some proponents within government and industry who believe that within the next 5-10 years, UAS will begin commercial civil operations. They assert that these UAS operations will be conducted in the same oceanic, en route and terminal airspace where air carriers operate. Some advocate that in the future, UAS operations may perform many of the same types of operations as currently conducted by commercial operators using aircraft with onboard pilots.

The Air Line Pilots Association’s (ALPA’s) position is that no UAS should be allowed unrestricted access to public airspace unless it meets all the high standards currently required for every other airspace user. UAS operators must meet all the certification and fitness requirements of air carriers, and the “pilots” flying the UAS aircraft must meet equivalent training, qualification, and licensing requirements as pilots of aircraft in the same airspace.

ALPA believes the fundamental function of operating the aircraft in a safe manner must be maintained at the same level of safety regardless of the location of the pilot or levels of automation. Current commercial aviation is pilot centric and a well-trained, well qualified pilot remains the single most important safety component of any commercial aircraft. Current DoD UAS operations are neither designed nor operated to the same standard as an airline aircraft and the pilots in some instances are not required to have the same training and experience as other DoD pilots and certainly not as commercial airline pilots. Significant design and operational safety improvements must be made before UASs can safely share airspace with airliners carrying passengers, cargo, and crews.

Background

The development and use of UAS has a history that exceeds fifty years. Throughout this timeframe, however, the development and use of such systems has been primarily been limited to military organizations. Operations were conducted in either segregated airspace, such as Special
Activity Airspace (SAA), in combat areas, or other hostile environments. Since the terrorist attacks of September 11, 2001, technological advances in electronics, airframe construction, surveillance techniques, and other related areas has resulted in unprecedented growth in the interest in and development of UAS for both military and commercial purposes.

The UAS currently used by the military services, other government agencies, and civil enterprises are significantly advanced in both size and operational capabilities when compared to their predecessors. They have an operational envelope ranging from extremely low level flying to altitudes and endurance well beyond that of typical civil aviation aircraft. The airframes of these aircraft vary from fixed- and rotary-wing aircraft the size of the smallest hobby aircraft, to fixed-wing turbojet and propeller-driven aircraft with wingspans in excess of 100 feet. In addition, there are lighter than air and vertical thrust designs, adding to the challenge of developing standards for operation. These aircraft are used primarily for surveillance, border patrol, anti-terrorist surveillance, military strategic and tactical missions, and weapons delivery. Proponents have advocated using UAS for highway traffic control, search and rescue, pipeline and critical infrastructure surveillance, environmental monitoring, agricultural application, medical supply and pathology sample transport, small package delivery and a host of other civil uses yet to be developed.

DoD operates a large number and variety of UAS ranging from hand-launched aircraft to the Global Hawk and Predator, which are capable of high altitude, long endurance flight and are controlled via satellite communications. DoD has concentrated on operations in combat airspace, but as its UAS combat mission expands, so does the requirement for domestic training and infrastructure support. With these increases come a greater need for access to airspace, and even if this airspace is segregated, increased pressure is placed on the National Airspace System (NAS). In addition, it brings increasing motivation to operate UAS in unsegregated airspace. These operations are transitioning from Special Activity Airspace (SAA) to mixing with other aircraft in both controlled and uncontrolled airspace. While highly trained military pilots and selected manufacturer’s pilots fly Global Hawk and Predator in the NAS, the Army and Marines fly their smaller UAS using non-rated “operators” with little or no traditional pilot training.

ALPA recognizes the benefits that UAS may provide valuable national defense and law enforcement functions domestically. However, the introduction of such aircraft into an integrated national airspace system represents an entirely new concept that has the potential to profoundly degrade the safety of both commercial and general aviation flight operations if this integration is not accomplished in a responsible, comprehensive manner.

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The stated goal of UAS proponents is to integrate operations into the
nations’ airspace to the extent possible without degrading the existing general aviation level of safety and minimizing any changes to standard airspace rules and procedures. However, many of the intended uses of UAS would be in areas where typical general aviation aircraft do not (and indeed are not permitted to) operate. Many UAS are not capable of completely satisfying these requirements in any airspace, and therefore such operations must be restricted to segregated airspace, clear of the travelling public. ALPA believes that the level of safety must be required to be the same as commercial air carrier operations.

The scope of the interest in UAS is now international, with aggressive development efforts underway in a number of nations. Although there is considerable activity to develop standards, there are no internationally agreed upon standards for the design or manufacturing of aircraft, control stations or control devices, operating software, means of communications between the pilot and aircraft or pilot and air traffic management system, and the training and certification of pilots. The USAF has begun enrolling UAS pilots in its new ab-initio UAS pilot training, and major aviation-focused universities have begun offering UAS courses. However, there are a multitude of concerns and questions that must be resolved and sets of regulations implemented before any such concept of a seamless integration of UAS into the airspace of any nation can be considered. ALPA believes the issues and recommendations listed later in this paper must be addressed during the process of determining the suitability of integrating UAS with other civil aviation operations.

Challenges and Concerns

There are industry and government activities underway in North America and other parts of the world oriented toward addressing the challenges and concerns associated with attempts to integrate UAS into unsegregated airspace within the entire spectrum of civil traffic. These include the Department of Defense (DoD), Department of Homeland Security (DHS), the National Aeronautics and Space Administration (NASA), the Federal Aviation Administration (FAA), Transport Canada, RTCA in the US and its counterpart EUROCAE in Europe. The International Civil Aviation Organization (ICAO) has published a circular to guide the development of harmonized standards and practices for UAS. That document states:

“The goal of ICAO in addressing unmanned aviation is to provide the fundamental international regulatory framework through Standards and Recommended Practices (SARPs), with supporting Procedures for Air Navigation Services (PANS) and guidance material, to underpin routine operation of UAS throughout the world in a safe, harmonized and seamless manner comparable to that of manned operations. This circular is the first step in reaching that goal.”

While we are aware of a number of accidents and significant incidents involving UAS, accessibility to public-use UAS accident/incident data is
limited. Inasmuch as the non-governmental use of UAS is in its infancy, there is no detailed publicly available data on accident or incident rates for UAS. However, the accident/incident history that is public, regardless of rate, suggests the need for more robust safety standards before UAS can be considered “as safe” as other users of the airspace.

One concern is that, by definition, it is impossible for a UAS pilot to react to an unannounced malfunction. A pilot on board an aircraft can see, feel, smell or hear many indications of an impending problem and begin to formulate a course of action before even sophisticated sensors and indicators provide positive indications of trouble. Some currently discussed plans for UAS operations would allow a single pilot to control more than one aircraft, leading to an increased potential for being distracted from trouble on one simply by having to conduct normal operations on another. A failure unique to UAS is the phenomenon of “lost link.” The term “lost link” has been used several ways, but the most technically accurate meaning is that the “command and control” signals from the pilot, the signals that tell the aircraft to turn, climb, descend, and so forth, are no longer being received by the UAS aircraft. While most UAS have pre-programmed instructions on which that aircraft relies in such an event, the fact that the pilot is no longer in control of the aircraft when the aircraft is potentially near airspace occupied by other conventionally piloted aircraft is a safety concern. At present, no requirement exists to report all such events to a government agency (e.g. FAA or NTSB) so ALPA is concerned that the frequency of “lost link” with the UAS is more prevalent than is currently being reported.

Some studies have been conducted to evaluate this issue. DoD, in its 2005 UAS Roadmap, examined the role of manned operations and of UAS operations in combat areas. The document acknowledges that the use of UAS to replace piloted aircraft and potentially limit human losses must be weighed against the limitations of the UAS. The roadmap also acknowledges the ability of the pilot on the flight deck to perform many pilot duties better than a pilot on the ground operating a UAS. In the words of Gen John P. Jumper, USAF Chief of Staff.

“On the one hand, in the eyes of policy makers, the risk to a cockpit pilot (i.e., of becoming a casualty or prisoner of war) detracts from manned operations. On the other hand, we have shown that in certain situations a pilot in the cockpit has the edge because of his or her superior ability to reason, maintain SA [situational awareness], and subsequently take the fight to the enemy. The line between combat effectiveness and risk to the shooter is often as fine- and controversial- as the one between warriors and policy makers themselves. We seek to answer the questions about cost-benefit analysis that define this doctrinal compromise. To do so, we must first identify those strengths and weaknesses inherent to this piece of technology so that we can leverage their capability to a greater degree.”

“I think there’s no doubt UAVs have come of age. The Predator UAV we have deployed around the world has done superb work for us. We see UAVs like Global Hawk that have stayed airborne for long periods of time. I think these will eventually replace manned reconnaissance aircraft. We will eventually have a conventional bomb-dropping capability also. This
UAS operating in airspace with other civil traffic should have transponders or Automatic Dependent Broadcast – System (ADS-B) as well as an Airborne Collision Avoidance System (ACAS) installed, helping other aircraft and ATC identify them in the airspace. In addition, UAS designs must allow the aircraft to safely maneuver in a timely, effective manner to avoid an air-to-air conflict as well as comply with ATC instructions.

ALPA believes that it is doubtful that either civil UAS operations or even unrestricted DoD UAS operations in the NAS will occur in the next 5-10 years as proponents envision. The role of the pilot located on-board the aircraft remains critical to safe operations. Other ALPA UAS concerns include the system’s ability to:

• Comply with rules of the air,
• Sense and avoid all other traffic in order to comply with existing FARs,
• Maneuver to maintain required separation and avoid collisions with other aircraft,
• Perform and maneuver comparably to other aircraft,
• Operate in congested air traffic areas without requiring extraordinary surveillance or control, thus taxing an already overburdened ATC system, and,
• Detect and avoid weather. This is a more acute problem for UAS than other aircraft because UAS are not designed with the same all-weather-capability systems to deal with thunderstorms, wind shear, icing, hail, etc. as are other aircraft in the airspace.

UAS operating in airspace with other civil traffic should have transponders or Automatic Dependent Broadcast – System (ADS-B) as well as an Airborne Collision Avoidance System (ACAS) installed, helping other aircraft and ATC identify them in the airspace. In addition, UAS designs must allow the aircraft to safely maneuver in a timely, effective manner to avoid an air-to-air conflict as well as comply with ATC instructions.

UAS are well suited to highly automated operations. However, like other aircraft, a pilot must retain the ultimate authority for the safe operation of the aircraft. ALPA is concerned about initiatives to develop “autonomous” UAS meaning operations without allowing human input to the management of the flight. While various levels of automation may be developed to support the UAS pilots, UAS that are “autonomous” are unacceptable in an interactive and dynamic NAS.

Present Use of UAS

DHS uses UAS for border surveillance. DHS current and projected uses continue to expand and include monitoring of ship traffic and harbors, hazardous cargo shipments, nuclear reactors, etc. Due to the sensitivity of the missions, this surveillance and monitoring would be conducted without public warning or notification. Unlike the DoD, which usually operates away from congested airspace, some DHS UAS proponents are advocating operations like the monitoring of ships in the New York harbor. These operations would affect commercial air carrier and general aviation flights into the New York Metroplex. DHS UAS proponents have also proposed operating the UAS aircraft without a licensed pilot, but using a minimally trained “operator.”

NASA has recently increased its support for research in unmanned systems and the means to allow their integration into the NAS. In 2010,
To attain the Target Level of Safety, the FAA must evaluate operational procedures that may need to be modified to provide for UAS unique needs. A further understanding of the design and limitations of the aircraft will be required so that appropriate levels of safety assurance can be developed.

UAS Standards

In late 2004, the Aircraft Owners and Pilots Association (AOPA) asked RTCA and the FAA to convene a special committee (SC) on UAS. In December 2004, RTCA SC-203 held its first meeting. Composed of government and industry members, SC-203 is developing performance standards for overall UAS systems and subsystems. Industry participants include UAS manufacturers, potential operators, general aviation, and other airspace users. In particular, the group is developing one standard for sense-and-avoid equipment that is expected to allow compliance with the 14CFR Part 91 requirement for “see and avoid” and another for the minimum standards for UAS command and control communications. While some manufacturers contend that UAS are not aircraft and that the “operator of the UAS in flight” is not a pilot, the FAA has not supported these concepts. Nick Sabbatini, former Associate Administrator for Aviation Safety, stated at the opening of RTCA SC-203:

“...the aviation version of the Hippocratic Oath must also apply here: First, do no harm. In introducing unmanned aircraft systems to civil airspace we must first do no harm — have no adverse impact to those thousands of aircraft already operating in the NAS. ...With the burgeoning civil market, and the desire to “file and fly” these aircraft in a manner so that they are transparent to other airspace users, a new FAA paradigm must emerge. This paradigm includes a methodical introduction of civil UAS into the NAS demonstrating a level of safety equal to or exceeding that which exists today.”

To attain the Target Level of Safety, the FAA must evaluate operational procedures that may need to be modified to provide for UAS unique needs. A further understanding of the design and limitations of the aircraft will be required so that appropriate levels of safety assurance can be developed. Authorities must not limit the scope of approval to certification of just the aircraft, but also the complete system, including the data link infrastructure, ground control station, as well as the pilot/controller communication components.
Conclusions

In the near term, UAS will probably concentrate on performing operations that fall under the 3Ds – dull, dirty, or dangerous. These activities include surveillance, both high altitude (above FL410) and low altitude, mapping, communications relay, etc. ALPA is continually monitoring these evolving missions and participating with all applicable government/industry groups to ensure that the level of safety is maintained at or above the existing level for commercial aircraft operations.

Current UAS level of safety is relatively low and must be improved significantly before the aircraft can safely operate with other aircraft in the NAS. The issues of air traffic control and communication procedures, pilot procedures and qualifications, security, human factors, and operational integration of vastly dissimilar aircraft into the NAS must be resolved. UAS operations do not have an operational record sufficiently well developed to justify the replacement of traditionally piloted aircraft in commercial operations. If UAS operations can be shown to have reached and maintained a level of safety that matches the current high level of safety in commercial aviation, then, and only then, can expansion of UAS into the NAS be considered.

While ALPA is involved with government/industry forums that are addressing the UAS safety questions and dedicated to raising the UAS level of safety, there are a number of equally challenging industrial questions that must be raised before the FAA and industry can consider using new technologies to replace well-trained, highly qualified pilots from commercial aircraft. The scope and direction of these industrial questions will not be fully known until the safety questions are resolved and the UAS advocates proposals are presented to the FAA for approval.

ALPA continues to be committed to providing the necessary expertise and resources to assure the required target level of safety for operations in the NAS is assured before consideration of any plans to allow UAS operation above, below or within the same airspace as our members’ aircraft operate.

Recommendations

In 2007, the ALPA Executive Board formally directed the President of ALPA to ensure all appropriate resources are available to accomplish the following broad tasks:

1. The completion of a comprehensive FAA safety analysis case that includes human factors, to validate that the introduction of UAS into the NAS will not degrade the existing NAS Target Levels of Safety.
Continued ALPA participation in industry and FAA efforts to develop and implement the new rules, regulations, security measures, and procedures necessary to safely accommodate UAS operations (civil or military) into the NAS.

Support for FAA efforts to ensure all components of UAS certified by the Department of Defense and other government entities do not adversely affect the NAS level of safety prior to their operating in other than segregated airspace.

Use of all ALPA resources necessary to ensure onboard pilots remain in command of any type of commercial air transport operation.

Within that framework, ALPA has developed the following recommendations as guidance for our efforts in the development of UAS standards and procedures:

1. Standards must reflect commercial (not general aviation) operations regulations and metrics to ensure an equivalent level of safety.
2. Appropriate additional new rules, regulations and procedures must be adopted to safely accommodate UAS (civil or military) into the NAS.
3. Regulatory directives containing certification standards and MEL requirements for UAS that are intended to operate in the NAS must be developed.
4. Federal Aviation Regulations that specifically addresses UAS operators, operations, and pilots must be developed. Any UAS-unique or UAS-specific regulations must be comparable and compatible with other existing regulations for other airspace users.
5. Any person or persons in direct control of a UAS must be limited to the control of a single aircraft unless operations are conducted in Special Activity Airspace.
6. Any UAS operating in controlled airspace in the NAS must be flown by pilots who meet equivalent standards as pilots of manned aircraft or the aircraft must be operated in segregated airspace.
7. Certification standards for the UAS pilots must be established to ensure the continuity of safety that now exists in the NAS.
8. In order to assemble an accurate performance assessment of UAS operations the FAA should establish a reporting and tracking system to insure that UAS systems including that for command and control (link) function safely and reliably.

In 2007, the ALPA Executive Board formally directed the President of ALPA to ensure all appropriate resources are available to address challenges for safely operating in the National Airspace System.