Assessing the Risks of Integrating Unmanned Aircraft Systems into the National Airspace System

Unmanned Aircraft Systems (UAS), more commonly called drones, have the potential to save lives, reduce risk, and fundamentally change the way some jobs are performed. In January 2018, lifeguards in Australia used UAS to drop inflatable life preservers to swimmers in trouble, responding much faster than they could in person and without risking additional lives. UAS could be used to respond to other emergencies by helping firefighters monitor wildfires or delivering defibrillators to those in cardiac distress. UAS also offer new ways to prevent disasters before they happen, such as the long-range inspection of rail lines to avoid potential derailments. While the many potential applications for UAS are promising, UAS pose new and uncertain risks to people in piloted aircraft and on the ground. At the request of the Federal Aviation Administration (FAA), the National Academies of Sciences, Engineering, and Medicine organized a study to evaluate the risks of integrating Unmanned Aircraft Systems (UAS) into the National Airspace System. The study committee believes that the introduction of a robust set of UAS operations is achievable and has the potential to provide significant net safety benefits to society. The report provides findings and recommendations intended to help FAA foster an environment where UAS can operate safely while also contributing to public health, safety, and economic growth.

COMBATING A RISK-AVERSE CULTURE AT THE FAA

The fear of making a mistake drives a culture at the FAA that is often overly conservative with regard to UAS technologies, especially given that UAS technologies do not pose a direct threat to human life in the same way as technologies for manned aircraft. Because risk avoidance behavior is often rewarded at the FAA even when excessive, staff may feel that allowing new risks could endanger their careers even when that risk is minimal and does not exceed established safety standards. The FAA should combat this risk-averse culture by establishing an incentive system that measures, promotes, and rewards individuals who support balanced comparative risk assessments. In addition, to demonstrate that the agency values risk assessments, it should publicly commit to ensuring timely reviews of risk assessments.

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RECOMMENDATION: Within 6 months, the FAA should undertake a top-to-bottom change management process aimed at moving smartly to a risk-based decision-making organization with clearly defined lines of authority, responsibility, and accountability. To that end, the FAA should establish and maintain technical training programs to ensure that agency risk decision professionals can fully comprehend the assumptions and limitations of the probabilistic risk assessment techniques appropriate to current and future UAS operations.

IDENTIFYING ACCEPTABLE RISKS

The study committee concluded that when it comes to evaluating the safety of new UAS technologies the FAA should ask the questions "How can we approve this?" and "Can we make UAS as safe as other background risks that people experience daily?" With regard to the risk that an aircraft accident poses to people on the ground, the public already accepts a background level of risk that is extraordinarily low. Therefore, when establishing safety standards for small UAS operations, it will be helpful to understand the level of risk that the public can accept in the context of the risks they already accept for activities such as traveling by car or walking across the street.

RECOMMENDATION: Where operational data are insufficient to credibly estimate likelihood and severity components of risk, the FAA should use a comparative risk analysis approach to compare proposed UAS operations to comparable existing or de minimis levels of risk. The FAA should research and publish applicable quantitative levels of acceptable risk

in comparison to other societal activities that pose de minimis risk to people. Risk level and risk mitigation strategies should consider not only aircraft collisions but also third-party risks (e.g., to people on the ground).

Due to the lack of empirical data for the UAS industry, the current FAA approach to risk management is based on qualitative and subjective risk analysis. This qualitative approach requires a depth and breadth of subject matter expertise that the FAA generally does not possess for UAS operations. By investing in risk analysis, modeling, and engineering assessment and more strongly relying on applicant expertise, the FAA could move towards making decisions based on a more quantitative probabilistic risk analysis.

RECOMMENDATION: Within the next 12 months, the FAA should establish and publish specific guidelines for implementing a predictable, repeatable, quantitative, risk-based process for certifying UAS systems and aircraft and granting operations approval.

RECOMMENDATION: Over the next 5 years, the FAA should evolve away from subjectivities present in portions of the Order 8040.4B process for UAS to a probabilistic risk analysis (PRA) process based on acceptable safety risk. In the interim, the FAA should improve the 8040.4B process to conform better with quantitative PRA practice. For the new acceptable risk process, the FAA should consider relying on the applicant to provide a PRA demonstrating the achieved level of safety, as is common in other regulatory sectors such as nuclear, dam, or drug safety.
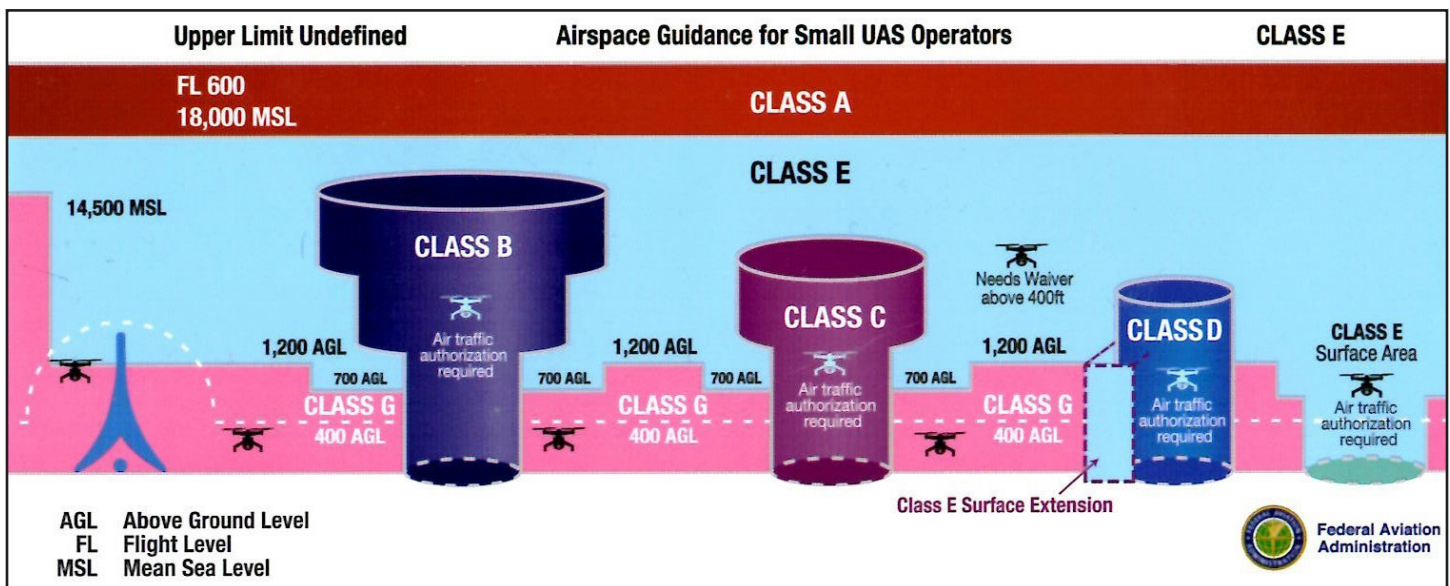
Airspace classification in the National Airspace System. SOURCE: FAA

ENCOURAGING INNOVATION AND IDENTIFYING SAFETY BENEFITS DERIVED FROM UAS TECHNOLOGIES

Traditionally in manned aviation, assessments of risk have focused on the probability of passenger fatality. This measure clearly does not correspond well to UAS operations, especially when considering that some UAS operations will increase safety both inside and outside the aviation system.

RECOMMENDATION: The FAA should expand its perspective on a quantitative risk assessment to look more holistically at the total safety risk. Safety benefits, including those outside of aviation (e.g., the benefit of cell tower inspections without a human climbing a cell tower), should be part of the equation. UAS operations should be allowed if they decrease safety risks in society—even if they introduce new aviation safety risks—as long as they result in a net reduction in total safety risk.

Given the substantial variety of types of UAS operations, no one single measure of risk can adequately characterize the benefit and risk of all UAS operations. Overly stringent certification requirements for relatively low-risk operations place unnecessary burden on businesses and can stifle innovation.

RECOMMENDATION: The FAA should identify classes of operations where the level of additional risk is expected to be so low that it is appropriate to base approval of those operations on requiring insurance in lieu of having a separate risk analysis.

A NEED FOR MORE DATA

In the current environment, uncertain risk has made operational approvals for routine civil UAS operations difficult to obtain and, when issued, unnecessarily restrictive. As a result, the ability to collect data that might reduce uncertainty in the risk has been severely limited. Rapid advances in autonomous vehicle technology are providing effective integration of sensors and analytics, and these developments present an opportunity for the FAA to learn and test new models for better data collection and analysis with the aim of improving overall safety.

RECOMMENDATION: The FAA should, within 6 months, collaborate with industry to define a minimum operational safety data set and develop a plan for the voluntary collection and retention of data by the operators in a central repository, following the model of the Commercial Aviation Safety Team

(CAST) and the General Aviation Joint Steering Committee (GAJSC), with a goal of full implementation within 1 year. The FAA should also consult with the Drone Advisory Committee to help define the minimum operational safety data set and plan for collecting, archiving, and disseminating the data.

It may be difficult to collect enough data to assess some risks that have a very low probability of occurrence. In those cases, it could be useful to draw upon research and experience in other fields where limited data is combined with simulations to draw conclusions about safety.

RECOMMENDATION: For operations approvals for which there are no standards, as operational data are collected and analyzed, the FAA should, as part of Improved Safety Risk Management,

- Publish requirements for operational approvals with associated restrictions that can be adjusted and scaled based on industry past experience and the accumulation of related data;

- Expand single operation approvals as experiential data accumulate and risks are assessed;

- Permit repeated or routine operations based on the accumulation and analysis of additional data; and

- Continuously update operational approval practices to incorporate emerging safety enhancements based on industry lessons learned until standards have been established.

Increased levels of autonomy have the potential to improve the operational safety of UAS. However, it cannot currently be guaranteed that such a non-deterministic learning system would respond safely in every conceivable situation. For this reason, true autonomy, as opposed to well-defined automatic operation in well-defined circumstances, is not currently allowed for commercial UAS flying within the National Airspace System. Opportunities to increase the safety of UAS operations, and of aviation in general, through increased autonomy are being missed due to a lack of accepted risk assessment methods.

RECOMMENDATION: In coordination with other domestic and international agencies, the FAA should pursue a planned research program in probabilistic risk analysis (PRA), including the aspect of comparative risk, so that FAA personnel can interpret or apply PRA for proposed technology innovations.

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