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The Importance of Drone Impact Testing for Small Aircraft Systems

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The U.S. Federal Aviation Administration (FAA) currently receives more than 100 reports of unmanned aircraft system (UAS) sightings every month from concerned pilots and members of law enforcement.[1] This number has grown significantly over the past two years and is expected to further rise as the consumer and commercial use of drones expands. In October 2018, the FAA repealed Section 336, which exempted hobbyist drones from FAA oversight, in favor of more stringent controls over model aircraft. Thus, hobbyist drone use will now fall under FAA control.

If drone operators follow the rules outlined in Title 14 CFR part 107 (or the recently repealed Section 336), aircraft and small UAS should never collide.[2] However, many drone operators fail to adhere to these regulations and unknowingly put small aircraft systems at risk. In 2017, the operator of a small UAS flew the drone out of visual range and collided with a U.S. Army Sikorsky UH-60M Black Hawk helicopter.[3] While the helicopter landed safely, the drone dented one of the helicopter's rotor blades, partially lodged in the engine oil cooler fan, and caused $1.6M in damage.

The aircraft industry and government regulators are aware of the potential hazards that drones may cause to helicopters and other small aircraft, but no specific requirements currently exist for testing the impact of drone strikes, and the size and scope of risk (probability times severity) are unknown. Formal efforts to collect and evaluate drone and aircraft near miss and collision data can help aircraft manufacturers and regulators understand the probability of drone strikes on aircraft and help inform future FAA operational regulations. Further research and testing is required to understand the severity of the potential danger that a drone/aircraft collision poses to the aircraft, which will depend on the details of the drone, the aircraft, and the collision itself.

While it is known that drone operators do not always follow 14 CFR part 107 (or the repealed Section 336 for hobbyists)—which prohibits small UAS from flying at night, out of line-of-sight, above 400 feet, and within five miles of an airport, national park, or restricted airspace—the probability of drone/aircraft collisions actually occurring is not well understood. Assessment of drone and aircraft near-miss and collision data can help define the specific speeds and altitudes at which a drone/aircraft collision could reasonably occur. For example, is a drone strike on a small aircraft more likely to occur at 150 to 200 mph in cruise, or is it more likely to occur while the aircraft is at speeds of 100 mph or less while taking off or landing? What are the probability differences of a collision with a drone among commercial jet traffic, personal light aircraft, and police/medical/media helicopters? Effective drone/aircraft collision probability evaluation can help manufacturers understand what additional measures (e.g., flight envelope restrictions or geo-fencing) might be useful in reducing the probability of a collision.

Impact testing can demonstrate the effects (severity) of a drone/aircraft collision. The effects of a drone/aircraft collision are presently not well understood. Many people assume that because drones are small and light weight,

[1] https://www.faa.gov/uas/resources/public_records/uas_sightings_report/
[2] https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=20516
[3] https://www.ntsb.gov/news/press-releases/Pages/PR20171214.aspx

they do not pose a safety hazard, or that all aircraft are certified for bird strike and by extension, drone strike. This is not the case. While commercial airplanes have long met bird strike requirements, many helicopters and other aircraft that fly at lower altitudes were built under regulations that did not require any consideration of impact damage from birds, let alone drones with very different mechanical properties. In 2009, a collision with a two-pound red-tailed hawk resulted in the crash of a helicopter and the death of 8 of the 9 people on board,[4] and many drones exceed this weight today. Even drones that weigh less than birds may cause damage to aircraft structure or engines that are certified for bird strike due to dense parts, such as electric motors.

Finally, testing of realistic collision scenarios between drones and aircraft can help inform future FAA safety regulations. The FAA is currently focused on increasing drone registration and optimizing small UAS/manned aircraft separation. Exponent has performed analysis that indicates that small UAS keep-out zones can reduce risk to manned aircraft. Drone impact tests can provide additional data to help policy makers understand how regulations may need to be changed.

Exponent's multidisciplinary team includes experience manned and unmanned pilots and members of various committees addressing aspects of Unmanned Aerial Systems. Our engineers leverage our test facilities to assess both the probability and severity of drone/aircraft collisions, to evaluate whether damaged aircraft would remain flyable given certain damage, and to support data-driven regulatory discussions.

[4] http://www.aopa.org/asf/ntsb/narrative.cfm?ackey=1&evid=20090104X12037

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