CHAPTER 3: DRONE REGULATION-PRIVACY AND PROPERTY RIGHTS

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This chapter explains some general principles of drone regulation by national governments and asks how both air safety and privacy will be shaped by new technologies. It puts forth the claim that taking property rights in the air seriously is a way to allow innovation while protecting safety and privacy. The chapter is not an exhaustive discussion of the specifics of particular regulatory regimes. Up-to-date links to individual countries' regulations are available at drones.newamerica.org/#regulations

As far back as 1944, when the Chicago Convention on International Civil Aviation established the International Civil Aviation Organization (ICAO), the international umbrella body for aviation regulators, authorities were considering the implications of "pilotless aircraft." Article 8 of the convention prohibited "aircraft capable of being flown without a pilot" from trespassing over the territory of contracting states without permission and further obligated the fifty-two signatories (nearly all sovereign states now adhere to the convention) to "insure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft."[1]

Just what it means to obviate that danger is a question that national aviation regulators around the world are wrestling with. The chief danger that unmanned aircraft pose to manned aircraft is accidental collision.* This is for two reasons. The first is the sheer number of small unmanned aircraft. There are already more small drones than exist general aviation aircraft, and that number will only grow. The air will become more crowded than ever before. The second is the limited situational awareness that drones have. Though drones can be flown with so-called "First Person View" (FPV) cameras that provide some such awareness, regulators believe (based on a track record of military drones with somewhat similar systems) that FPV systems do not provide awareness comparable to a pilot within an aircraft. (Some drone-hobbyist users of FPV systems would disagree.) At some point in the future, drones may commonly have onboard systems that algorithmically avoid collisions. The vast majority of drones do not have such systems at present.

* This is a question of numbers; hundreds of thousands of small drones are being flown without malicious intent, while there are at most a very small number of would-be attackers. Deliberately crashing a small drone into an aircraft or helicopter is difficult because of the high speed of airplanes and the downdraft helicopters create, among other factors. Would-be malicious UAV users deliberately provoking midair collisions ought not to be the main concern of regulators. There have been dozens of recorded "near misses" in recent years (see Craig Whitlock, "Near-collisions between drones, airliners surge, new FAA reports show" Washington Post, November 26, 2014). There is no reason to believe any of these were attempted attacks.

The signing of the Chicago Convention of 1944 established ICAO. Though not a major concern at the time, the convention did mention "pilotless aircraft". Image from Wikimedia Commons.

In a century of manned aviation, a number of techniques for airspace management have been developed to prevent collisions. These might sound similar to a layperson but in fact entail distinct technical solutions.

The first is to segregate airspace. If manned aircraft and unmanned aircraft fly at entirely different altitudes, then there is no risk they can collide. At worst, unmanned aircraft could collide with one another, which would not involve loss of life. This approach means excluding drones from the vicinity of airports used by manned aircraft and confining them to low altitudes where manned aircraft are already prohibited from flying. However, because of exceptions—like medevac helicopters, which must fly at low altitudes and must have freedom to go almost anywhere at short notice to complete their missions—total segregation is not possible. It is, however, the principle behind restrictions, in many jurisdictions, that confine small drones to low altitudes.

However, low-altitude flight implicates privacy; low-flying drones can more easily take pictures that infringe on privacy and can create noise that is an "intrusion upon seclusion."* Thus, some have proposed segregated bands for drone flight between, say, 500 and 700 feet above the ground that would be reserved for unmanned aircraft. Similar bands for larger unmanned aircraft at higher altitudes could segregate them from manned aircraft. If airspace control systems were being designed from scratch, such bands would be a logical solution. However, they are not likely to be implemented in any jurisdiction because they run counter to the legacy of how airspace has been regulated.

The next mechanism for preventing crashes is to maintain "separation" between aircraft. This works in controlled airspace, where air-traffic controllers keep track of where both manned and unmanned aircraft are. It allows, for example, Predator drones flown by the U.S. government to patrol the U.S.-Mexico border. It also is what has allowed the airport in Kandahar, Afghanistan, to function. The airport was for some time the world's busiest single-runway airport,[2] with more than 800 takeoffs and landings per day—civilian and military, manned and unmanned, all mixed together. Air-traffic controllers managed this airspace by keeping a minimum of 1,000 feet of separation between drones and manned aircraft and 500 feet between one drone and another.[3]

There does not exist, for the moment, a system for maintaining separation between small drones. (To the extent that drones have been integrated into air-traffic management schemes, like that in Kandahar, it has been large drones whose operators have been able to speak with air traffic controllers.) For such a system to work, controllers must be able to both see all relevant aircraft and direct them. Small drones fly at lower altitudes, where radar coverage is difficult; there are many more of them, and because small drones have very limited payload capacity, systems that allow them to interact with air-traffic control and other aircraft must be carefully designed.† NASA is developing a system that would act as a global surveillance system for small drones at low altitudes.[4] (This is, at present, by way of a technological experiment, rather than a concrete scheme to be implemented at a national level.)

As a backup in case separation measures fail, passenger aircraft are required (throughout the world) to have a Traffic Collision Avoidance System (TCAS), which is an automated system in which transponders on aircraft communicate with one another and alert pilots to the risk of collision. In smaller aircraft, a pilot's eyes can suffice—the pilot is required to be able to "see and avoid" other aircraft. Developing systems for drones to "sense and avoid" other aircraft is an active area of research, as is determining how to regulate such new technologies.[5] Some consumer drones already have limited autonomous sense-and-avoid technologies, such as DJI's "Guidance" system.6 The capabilities of such autonomous systems are changing rapidly. It is difficult to venture predictions about how they will improve. Systems that work at low speeds won't do much good at high speeds; systems that work well in controlled testing may not be resilient in the real world. However, much may change quickly.

Larger drones can carry sophisticated sensors, cameras and gimbals that give the pilot good situational awareness (though not as good as that of a pilot in a manned aircraft). The FPV systems that smaller drones have provide a similar, though more limited capability. Such FPV systems can be used to race around obstacles at high speed.[7] This does not mean, however, that they provide the sort of peripheral awareness that a pilot in an airplane cockpit has. Latency with such systems is also an issue.

Many countries, particularly in the developing world, still do not have explicit regulations governing drones. However, in the United States, Canada, Europe, Australia, and elsewhere, a broad consensus on how to regulate drones has emerged in the past decade. The similarities among the various regulatory regimes outnumber the differences. That consensus is to allow more flexibility for smaller drones. These generally can be flown at low altitudes, far from airports, far from crowds, and within the line of sight. Some countries—France, for instance—permit flight beyond the line of sight for very lightweight drones. This is sensible and likely to become more common. The United States has lagged behind the United Kingdom, France, Germany, Australia, Canada, and elsewhere in the implementation of commercial drone flight regulations, however, the proposed rules which the Federal Aviation Administration (FAA)

* "Intrusion upon seclusion" is one of the types of privacy violation enumerated in the second restatement of torts, a compendium of common law (https://cyber.law.harvard.edu/privacy/Privacy_R2d_Torts_Sections.htm). There is no clear dividing line here; sophisticated military sensors can capture a great deal of detail from thousands of feet (indeed from space). However the small, cheap cameras common on consumer drones cannot capture much detail from, say, thousands of feet in the air. These boundaries will shift as camera technology improves.

† In the future, manned aircraft will, for the most part, carry a system called ADS-B that will actively transmit their position and altitude to other aircraft and to ground controllers. However, ADS-B systems may be too heavy for small drones; the system also likely does not have the radio capacity to handle the traffic of hundreds of thousands of small drones.

issued in February 2015 are broadly similar to rules in other jurisdictions, though they will likely not take effect until late 2016 or early 2017.

There are, of course, important differences between these countries. In Japan, for instance unmanned helicopters surpassed manned helicopters as crop dusters in 2004.[8] The reason this was possible, from a regulatory perspective, is that the crop-dusting drones (the Yamaha R-Max is far and away the market leader) though heavy, fly only at low altitudes over remote farms. They are thus regulated by the Japan Agricultural Aviation Association in conjunction with the Ministry of Agriculture, Forestry and Fisheries rather than the aviation regulator. The lesson from Japan is an important one insofar as it shows that regulating flight near the ground is not necessarily best done by aviation regulators, but perhaps by whichever body is responsible for regulating the relevant patch of ground—whether this be an agriculture ministry or local law enforcement. Indeed, Japan is lagging in implementing rules for non-agricultural drones. But the logical division of airspace has allowed it to attain preeiminence in one sector.

Within the emerging consensus for the regulation of small drones, many countries maintain legacy distinctions between recreational and nonrecreational drone use as a result of the history of hobby remote-controlled aircraft.[9] Such distinctions do not hold water today; as much as possible, recreational and nonrecreational users should have to follow similar rules based on the risk of where and how they are flying. Recreational and commercial users need not be subject to identical rules; however the divergence in rules ought to be minimized.

Take regulations concerning beyond line-of-sight flying. One major concern is the reliability of the radio link that connect control systems on the ground with drones. The Radio Technical Commission for Aeronautics (RTCA) standards for command-and-control data links[10] are a first step in this direction; the final standards, due to be released in July 2016, ought to provide a solid foundation for regulators to build on. Compliance with such standards and regulations ought not to turn on whether a flight is for recreational or non-recreational purposes—a distinction that is, in any case, a problematic one to make. Many hobbyists run photography business on the side, for instance; academics may fly both for fun and for research purposes.

The key challenge for aviation regulators is to figure out how to break free of the legacy of manned aircraft regulation. A fresh start would allow regulators both to avoid some of the absurdities that result when applying manned-aircraft regulations to unmanned aircraft, and to be attuned to the new threats to privacy that drones pose. The Riga Declaration on Remotely Piloted Aircraft, a March 2015 European Union document (which is not legally binding) put this well: "Drones need to be treated as new types of aircraft with proportionate rules based on the risk of each operation."[11] As of the summer of 2015, for instance, in the United States, would-be commercial drone operators who apply for a special exemption must have a manned pilot's license, even though flying a small drone remotely has little to do with flying a Cessna.

Many argue that harmonization of drone regulations is desirable, both among states within the United States and among nations around the world. Such standardization makes things easier for the commercial drone industry. However, as Margot Kaminski, a law professor at Ohio State University, has pointed out, it also has drawbacks.[12] Balancing the right to gather information (a First Amendment right within America) of people who fly drones with the right to privacy of those who can be seen by drones is not straightforward, and there is a case to be made for allowing different jurisdictions to experiment in different ways with finding this balance.

The balance to be struck between the freedom of a drone operator to operate uninhibited and the risks to safety and privacy drones can pose entails distinct legal considerations in different countries. In general, more open debate over these issues, in both the legal system and in academia, has taken place in rich countries like the US, Canada, Australia, Western Europe and Japan. The course these debates take in these countries will affect how drones are used in the rest of the world as well.

The drone-hobbyist community, though young, has already developed a rich tradition of tinkering. (The online epicenter of this is the website diydrones.com.) Even Chinese manufacturer DJI, which makes the Phantom, the world's most popular drone, meant to be easy for beginners to fly out of the box, sells a software development kit. Drones are, in certain respects, where personal computers were in the 1980s. Tinkerers with limited resources can, through ingenuity, compete with major manufacturers who make comparable products for many multiples of the price.

This vibrancy can be ruined by overregulation—in particular, requirements that drone hardware and/or software limit where drones can fly, or so-called "geofencing."[15] Such approaches ought to be met with skepticism. Though built-in restrictions like geofencing can often be circumvented by skilled users, they nonetheless inhibit innovation, without necessarily substantially improving safety or security.

THE PROBLEM OF PERSISTENCE

Indeed, the most difficult questions regarding drone regulation are not, in the end, related to safety. Safety questions are ultimately straightforward compared with privacy questions. For instance, persistence of drones in the air is not a threat to air safety but is a threat to privacy.[16]

At present, persistent surveillance using drones is not that cheap. Small, cheap UAVs do not have the endurance necessary for persistent surveillance. As sensor packages are further miniaturized and batteries improve, this will change. The expense and technical difficulty of persistence mean that it is not now within the reach of many private actors. This too will change with new technologies such as improved solar cells and lighter-weight, increasingly more capable sensors.

There is no clear line between persistent and episodic surveillance. Any narrowly written rule proscribing persistence could be evaded by flying a series of orbits, each for some amount of time shorter than the amount put forth as the maximum duration of persistence. Thus, much like anti-loitering laws (despite the fact that such laws have been abused), the line between persistent and episodic surveillance must be left to the discretion of the courts.

However, persistent surveillance must not be allowed by nongovernmental actors. Within the United States, many Fourth Amendment protections hinge upon a "reasonable expectation of privacy." If private actors can engage in persistent surveillance, it then opens the door for the state to do so as well. Existing tort law can be used to limit persistent aerial surveillance, but only if a court finds that solitude or seclusion can be violated by drones flying for long periods overhead. Such a case has not yet come to trial. Of course, not all persistent flight would meet a reasonable definition of surveillance. Environmental monitoring flights by scientists, for instance, might have good reason to stay in the air for months at a time, propelled by electricity from solar cells.

Much of this report is devoted to the use of drones by and for people who will be affected by the information drones gather. In cases where drones are flown above people who actively consent to—and are even involved in—the flight of drones, privacy concerns are diminished. They do not disappear, since questions around who gets to access data the drone gathered remain. (Such questions are addressed in Chapter 2.) Episodic information-gathering is a more straightforward process to consent to; many individuals might tacitly consent to persistent surveillance with a shrug. Consent alone is not a sufficient condition.

Limits on persistent surveillance from drones do not resolve the many important questions raised by other forms of surveillance. Monitoring the location data generated as a byproduct of widespread mobile-phone use amounts to another form of persistent surveillance. However, persistent aerial surveillance removes yet one more type of solitude. One can, at least in principle, not drive on a highway, not carry a mobile phone, or not send mail. The state should not treat all people as suspects who have yet to commit a crime. Private persistent surveillance would only normalize the technique for law enforcement and thus should also be prohibited.

PROPERTY RIGHTS IN THE AIR

One way to limit persistent surveillance has other ancillary—and significant—benefits. As Ella Atkins, a professor of aerospace engineering at the University of Michigan, argues, within the United States, the FAA ought to take seriously a 1946 Supreme Court decision, *United States v. Causby*.[17] In that case, the court found that military planes flying low over Causby's chicken farm were violating his property rights. "If the landowner is to have full enjoyment of the land, [the landowner] must have exclusive control of the immediate reaches of the enveloping atmosphere," Justice William Douglas wrote in the majority opinion. "The landowner owns at least as much of the space above the ground as he can occupy or use in connection with the land. … [T]he flight of airplanes, which skim the surface but do not touch it, is as much an appropriation of the use of the land as a more conventionalentry upon it."

The FAA has marginalized the *Causby* decision by arguing that drones expand the definition of "navigable airspace." Previously, areas

GTUAV via Wikimedia Commons

The Yamaha R-MAX unmanned helicopter has been in widespread use in Japan since the 1990s.

above 500 feet in rural areas and above 1,000 feet in urban areas, were deemed navigable, along with takeoff and landing corridors, because manned aircraft can't fly safely at lower altitudes. However, because drones can safely fly at low altitudes, the FAA now claims the authority to regulate "down to the blade of grass." Paul Voss, an engineering professor at Amherst College asks, "Can we fly a kite anymore? These strings are tremendously dangerous to Amazon's drones. Now the FAA has to worry about that."[18] The solution, he and Atkins say, is to give property owners control over the space above their property up to something like 500 feet. Though on its surface this raises enforcement concerns, the question is what the legal regime ought to be. The fact that it could only be enforced imperfectly is secondary; the question is what norms ought to be established as drones become common.

In the short term, such an embrace of property rights in the immediate reaches of air, would allow universities to conduct experiments on university-owned land* and private tech companies to do the same on privately owned land, so long as they made sure not to venture onto other people's property. It would allow farmers to use drones to conduct crop surveys and to dust crops. It would allow Amazon and Google to experiment and develop technologies that they might one day be able to use for delivery of goods in a way that doesn't intrude on anybody's privacy. There are myriad technical problems to be solved before a widespread drone delivery network becomes feasible—weather, for instance, is a big problem at low altitude, one that is poorly understood because the aviation community hasn't had to deal with it.

REGULATIONS AND APPLICATIONS

Just as taxi services raise different regulatory issues than does commercial trucking or non-commercial driving of automobiles, the regulatory questions facing drones depends on how they are being used. Community mapping—insofar as it is done with the consent of the community, with a relatively lightweight drone flown at a relatively low altitude is more straightforward, from the aviation regulator's point of view, than a network of heavier delivery drones that would extend over a large area. Drones taking photographs of disasters—where they might come into conflict with, say, firefighting aircraft or medevac helicopters—raise another distinct set of issues.

MINORITY GAME

Many drone pioneers see regulators as the enemy. Because the number of unmanned aircraft in the air has been relatively limited, it has been possible to get away with bending the rules in uncrowded airspace. One can fly a small drone, say, over the East River in Manhattan without it harming anyone in an obvious way, even though doing so is against government regulations due to the proximity to LaGuardia Airport. However, one can do this only if drones are rare. As drones become increasingly common, rules become increasingly important. The airspace will grow more and more crowded, making rules of the road vital.

There are aspects of those rules that are conceptually challenging to figure out. But there is no need to make them more complicated than they have to be. For instance, licensing requirements for commercial operators should not be needlessly onerous. According to Quartz, to get a commercial drone license in South Africa, after new rules implemented in the early summer of 2015, "could take over two months to process, and cost you anything between $1200 and $4000, depending on the size of your drone."[19]

International regulators should talk to one another and harmonize safety standards where possible. They ought not to adopt a one-size-fits-all policy, however, as the questions regarding drones' impact on privacy must be parsed differently in different countries with different conceptions of privacy. Standardized air-surveillance systems such as NASA's NextGen system for maintaining separation of drones from one another and from manned aircraft may prove necessary, even as they chip away at freedom of the skies. The regulatory trade-offs depend very much on how the technology evolves—the need for global surveillance schemes depends on how capable decentralized sense-and-avoid systems become. The more capable individual aircraft are of sensing and avoiding obstacles such as other aircraft, the less necessary a centralized system keeping track of where—and keeping apart—everything in the sky is.

There are no simple answers here. Regulators must listen to industry in order to understand the technical trade-offs, but must also avoid simply implementing the solutions desired by the unmanned-aviation industry, which will continue to grow rapidly in size and thus in influence in regulatory debates. FPV systems, for instance, are improving. Regulators should have enough discretion to sensibly adopt rules about beyond line of sight flight using FPV systems. Industry and drone enthusiasts should also understand that regulators' caution is not entirely without merit.

Many of these debates will be shaped by drones' capacity for autonomy and will have commonalities—how to approach liability, for example—with debates over autonomy in other related sectors, for instance with regard to driverless cars. What is clear is that aviation regulation—which has evolved to deal mostly with questions of safety—must now tackle privacy as well. §

* Academic researchers in the United States seeking to fly drones outside must currently jump through a number of regulatory hoops, which differ in detail depending on whether the university in question is public or private.

ENDNOTES

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