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"Unmanned Aircraft Systems"—Drones …Who Will Control Them?

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Resist the reflex

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Introduction

The FAA's notice of proposed rulemaking ("NPRM"), released on February 15, provides breathing space for a revolution in aviation. Both the regulation and the technology it addresses portend a new reality for a risk-based approach to enhancing aviation safety.

The FAA likes to call drones "unmanned aircraft systems," but almost everyone else calls them "drones." According to the NPRM, microdrones ("small UAS" or "sUAS") are unmanned aircraft that weigh less than 55 pounds. As the NPRM acknowledges, however, this is a wide weight range that encompasses vehicles with starkly different characteristics and capabilities. Of greatest immediate interest are vehicles at the smaller end of the range, ones such as the DJI Phantom and Inspire (a Phantom is what fell on the White House lawn), and 3Drobotics' IRIS+. These are multicopters, aircraft with multiple rotors powered by electric motors. Their battery capacity allows them to fly for 15 to 45 minutes at a time, and the limited range of their wireless control systems typically keeps them within the line of sight of the DRone OPerator ("DROP"). They carry small cameras capable of taking high definition video and streaming it live back to the ground.

They will supplement electronic newsgathering helicopters, offer new tools for real estate marketing, make construction-site supervision more efficient, and facilitate inspection of crops, bridges, power lines, and pipelines. Innovators in these industries have been straining at the starting blocks, waiting for the FAA to give general approval for commercial use of microdrones. Many have jumped the gun.

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[1] The author appreciates idea incubation for this paper from Eliot O. Sprague.

In the NPRM, the FAA wisely has taken a risk-based approach, and has molded its requirements around the realities of microdrone missions and the risks they pose. Recognizing the damage that detailed design specifications can do to technological innovation, it refrained from imposing airworthiness certification on microdrone vehicles. Recognizing the irrelevance of much of manned aircraft pilot training and its high cost, the agency sensibly developed a new knowledge test for DROPs, focused on what they actually need to know about Federal Aviation Rules, traffic separation, weather, and safe microdrone operation. Passing this test, and submitting to a TSA clearance, will entitle DROPs to a new "operator" certificate. DROPs must be retested every two years on their knowledge.

The NPRM does an excellent and persuasive job of explaining FAA's choices. An accompanying economic analysis by OMB shows that the cost benefit ratio implementing the proposed rule is quite favorable.

Developing a culture of compliance

Compliance with any rule depends on it being aligned, at least to some minimal extent, with the interests and norms of the target community. Requiring pilots' licenses, observers, and manned-aircraft-like maintenance manuals manifestly misaligns the requirements with the realities.

Until the NPRM turns into a final rule, commercial use of microdrones remains illegal unless one obtains an exemption from traditional aircraft rules under section 333 of FAA Revitalization and Reform Act of 2012, a process that is tedious and seriously backlogged. Moreover, under all of the 25 or so exemptions (out of a total of some 400 applications) the FAA granted before the NPRM was released required that the DROP have a conventional pilot's license, that the DROP be accompanied by an observer, and that other requirements be met, more suitable for airplanes and helicopters that microdrones. Despite the ban on commercial microdrone flight, hundreds – maybe thousands – of people ordered Phantoms, Inspires, IRIS+ and their competitors and flew them to support their professional activities, either in the ignorance of the ban or in defiance of it.

It is in everyone's interest to protect the NPRM's approach, despite undoubted changes that will be made to improve it. The goal must be a risk-based regulatory regime that encourages compliance because it seems legitimate and imposes costs commensurate

with benefits, one that provides incentives for the erection of a private training, testing, and safety infrastructure resembling the one that now exists for helicopters and airplanes.

Encouraging law-abiding autonomy

Appreciating the validity of the FAA's approach requires understanding microdrones' high level of automation and the autonomous safety features it enables. Multicopters maneuver by asymmetric trust from their, four, five, six, or eight rotors. The amount of thrust from any rotor depends on RPM, which in turn, is varied by changing the electrical current to the motor driving that rotor. One DROP control, like the cyclic stick on a helicopter, commands direction of flight: forward, sideways, or backward. The other, like the collective stick on a helicopter, commands all of the motors and rotors to increase or decrease their thrust symmetrically, to take off, hover, climb, descend, speed up, or slow down. These control inputs are fed over a wireless link, usually on WiFi frequencies, to the microdrone. There, onboard computers in the control board translate these commands into the necessary electrical inputs for each motor. No human operator is quick or agile enough to vary these currents manually. The control systems allow the DROP to issue commands much is he would fly a helicopter, except that the control systems stabilize everything, making it much easier.

The onboard control-system electronics that enable a DROP to fly a microdrone at all include magnetometers (electronic compasses), GPS receivers, accelerometers comprising internal management units, and sometimes downward-looking sonar, all of which allow the drone to determine its position in space. Only a little more is needed to enable automatic hover, automatic return to home, and flight planning features so that the DROP simply can designate the points to which the drone should fly. The drone then executes the flight plan autonomously. They also impose height, range, and speed limits, and exclude the drone from controlled airspace near airports.

These features justify the FAA's conclusion that only a light hand of regulation is necessary to keep everyone safe. It does not need to impose detailed design requirements, because the market is already delivering the designs.

Accommodating uncertainty

The genius of the NPRM is that it is not afraid to wait and see what actually happens. It recognizes some basic truths:

- Microdrones have great potential to boost the economy in certain industries
- The microdrones on the market, which predominate at the lower end of the weight continuum, combine miniaturized automation with low kinetic energy to make serious accidents extremely unlikely
- It not difficult to adapt the new technology so as to reduce the inherently low level of risk further.
- Much remains to be learned. There are not enough data yet on the risk profiles of different sizes of drone to enable rational segmentation of the regulated space.
- Operators need some basic knowledge to fly them safely, mindful of how conventional aircraft use the National Airspace System.

Actual patterns of commercial use must be allowed to develop, free of constraints based on guesses about entrepreneurial decisions. Only rudimentary projections can be made now as to where microdrones will be most popular. The NPRM advisedly invites comments on basic regulatory questions while recognizing that the most important uncertainties relate, not to legal formulations, but to patterns of use and actual risks that materialize:

- Can technologies such as first-person-view devices make flight beyond line of sight safe?
- Should the FAA impose of a horizontal boundary requirement or stick with the NPRM's qualitative line-of-sight rule?
- Should it require a flight termination system such as autonomous return-to-home?
- Should DROPs be subject to flight-proficiency testing or aeronautical experience requirements, in addition to the required knowledge test?
- Should online test-taking be offered?

Will microdrone technology change the character and frequency of privacy intrusions? Or will, as seems more likely, commercial operators be so busy pursuing profit and serving their customers to divert to peer into bedroom windows?

The flexibility that it offers does not mean, however, that the NPRM is completely open ended. It is, after all, a notice of proposed rulemaking and not a mere notice of inquiry. It is 197 pages long (in .pdf format), and is quite specific about the definitions, the contents of the broad knowledge test, the operating rules necessary to keep microdrones confined, and vehicle registration requirements.

Regulation of public-use drones is another matter. It is outside the scope of the NPRM, and use of drones by state and local law-enforcement and intelligence agencies is uniquely a concern of state government.

Larger drones—"machodrones"—likewise are another matter. As they approach the size and weight of helicopters and airplanes, they pose similar risks, and it well may be that they should be regulated like helicopters and airplanes, with detailed standards for airworthiness certification of the vehicles, traditional requirements for pilots, and specific flight rules relating to long distance navigation in variable weather conditions.

Manning the barricades

Now, the question is whether the FAA's sound approach can be defended against wrongheaded arguments for making the requirements tougher. Some of the challenges will be motivated by ignorance of the risks; some will be motivated by anti-competitive exaggeration of risks. No Phantom is going to "bring down a 747 full of passengers." The engines on a 747 must, in order to be certified, withstand ingestion of a goose weighing eight pounds, fired directly into the engine at 200 knots. The Phantom weighs less than three pounds and cannot fly faster than about 35 knots. The Phantom, unlike a goose, is made of frangible material.

Following technology

Too often, people lament that law is lagging technology, implying that it is better for the law to lead technology. That is not the case. Democracy and markets are best served when law follows technology. A new technology, like that for microdrones, is developed in labs and is introduced into the market. People buy it, try it out, and evidently discover problems. Disputes arise with vendors, with other people using the technology, and with those whom the technology impacts. Some of the disputes are trivial and get worked out; others more serious and lead to lawsuits. The courts decide the lawsuits, and after a few judicial decisions, enough data exist to begin to crystallize opinion as to whether the courts are getting it right or wrong. Only at that point are legislators and rulemakers well-positioned to make law. Now they can exercise their lawmaking power precisely to do what is necessary to correct the direction of judicial decision-making, to fill gaps, and to mold the law around actual problems.

Law is at its best when it waits to see what really happens.

The alternative is for lawmakers guess how entrepreneurs will use a new technology. They have to imagine what might go wrong, and then write law to reflect their imaginations. Imagination is a good thing, but it rarely matches reality, and the result is a body of law that constrains or distorts the potential for technology and fits actual human concerns poorly.

Twenty-five years ago I was one of a handful of engineers, lawyers, public-interest advocates, and policymakers who tried to foresee what the Internet would become. The federal government had just released the Internet from its tethers to the defense establishment and government-funded research labs. Even then, we could tell this disruptive new collection of technologies would raise some questions about access to infrastructure that might require rethinking common carriage, a challenge now confronting the FCC.

We thought about freedom of expression and about liability for harmful uses. But we didn't have a clue as to the details. Some form of e-commerce seemed like an eventual possibility, but everyone believed that a completely new medium of exchange would have to be invented first. It turned out that credit cards work just fine. We knew that intermediary liability for copyright infringement would chill development of the Internet's unbundled structure. Some of our number went to work with industry representatives and public interest advocates to craft the Digital Millennium Copyright Act, which combines intellectual property protection with safe harbors for well-behaved intermediaries. We did not, however, have any inkling of what Amazon, YouTube, and Facebook would become. We were pretty sure that bandwidth would need to grow, but everyone thought that the most interesting solution was ISDN. Anyone remember what ISDN was?

Keeping watch

Keeping an open mind does not mean abandoning the field. Much remains to be done at all levels of government. While the field of aviation safety is largely occupied by the federal government, restricting states and municipalities under the Supremacy Clause of the United States Constitution and the preemption doctrine, there always has been a role for state and local regulation of certain aspects of aviation safety. State courts and state law resolve claims of tort liability arising from accidents, as long as the standards for pilot conduct, operating rules, and aircraft design are those prescribed by the FAA.

Aircraft operations that recklessly endanger the public, that constitute disorderly conduct, that interfere with public safety officers, that trespass on land, or that invade personal privacy are local offenses or crimes and also constitute torts. The FAA recognizes the state and local role in regulating microdrone flight in a recent circular aimed at state and local law enforcement.[2]

The essentially local character of microdrone flights may alter the Commerce Clause analysis of aviation preemption. It is hard to find an effect on interstate commerce from the flights themselves—as opposed to sale of the vehicles. Unless a microdrone starts out very close to a state line, it lacks sufficient range to cross state lines. Under the NPRM, microdrone flights will occur below 500 feet within line of sight of the DROP, minimizing interference with the interstate commerce represented by airline and air charter flights, which may not legally occur below 500 feet. The Supreme Court of the United States has cautioned, in the *United States v. Lopez*[3] and *United States v. Morrison*[4] cases, against expanding the boundaries of the Commerce Clause by attenuated connections to interstate activities.

So what should the states do about this disruptive new technology, recognizing that "disruptive" is a *good* thing for innovation in competitive markets? First, they should be as interested in facilitating deployment of microdrones in the private sector as in restricting it. They should strive to protect the new possibilities enabled by microdrones against misguided local restrictions.

Second, they should turn a skeptical eye toward overblown claims, backed by no evidence, that civil microdrone operations will strip away the last vestiges of privacy, or that they threaten life and limb. Regulation at any level—federal, state, or local—should be tailored to reduce actual risks, not imagined ones. It probably is a good idea to prohibit drone flight directly over the heads of large assemblies of people at low altitudes. But that is not necessary to capture good video. Standing off at a 45-degree angle is the technique used by professional photographers and helicopter pilots. Any regulation addressing microdrone aerial photography should allow such nearby operation. Microdrones towing advertising banners can deliver their intended function

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[2] http://www.faa.gov/uas/law_enforcement/

[3] 514 U.S. 549 (1995) (affirming reversal of federal conviction for possessing firearm near school; outside Commerce Clause power).

[4] 529 U.S. 598 (2000) (affirming dismissal of civil claims for rape; outside federal Commerce Clause power).

by operating alongside bike paths and jogging trails. They do not need to fly directly over expressways. Microdrones supervising construction sites from the air or taking video to promote real estate for sale are unlikely to divert from their missions to peer in someone's bedroom window. Regulation should deal with reality, not with conspiratorial fantasy.

Third, states should talk to each other about a common approach. It is likely that a uniform or model state law should be drafted by the National Commissioners on Uniform State Laws. States and municipalities should have elbow room to craft their own solutions to local interests and opportunities. But they can learn from each other and should have available a common set of tools.

Fourth, states should nurture private organizations and associations that can help implement the NPRM's DROP testing requirements. Aviation has always relied mostly on private flight schools to deliver the training, testing, and certification of pilots; the same thing should be true for certification of DROPS under the NPRM. The FAA writes the knowledge test and contracts with test centers to administer it, but training for the test is the responsibility of the private sector. The FAA prudently avoided skills requirements or testing in the NPRM; that also will be developed and delivered by the private sector. State law determines the frameworks for these private sector actors.

Fifth, states should use their power to shape insurance regulation. Insurance coverage and limitations will do as much to shape conduct by drone operators as the law. Make sure that state insurance regulation does not interpose unnecessary restrictions on insurance markets' capacity to adapt to the growing demand for liability and hull insurance for microdrone operators.

Resisting the reflex

These little revolutionaries have the power to transform aviation. Resist the reflex to rush in and regulate them.

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For further reading:

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