CHAPTER

14

Issues of Unmanned Aircraft Insurance and Insurance Underwriting

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"For autonomous and unmanned technology to become a reality in our world, the risk transfer abilities of insurance and risk management skills of insurers will be key."

—Gillian Yeomans[1]

Adequate policies for unmanned aircraft insurance must provide coverage for three major areas of risk exposure: safety, privacy, and cybersecurity for data and storage. The main challenges for underwriters of these policies include the lack of historical data for an actuarial approach to underwriting, the need to extrapolate from aviation risk data and military unmanned aircraft experience, and the highly regulated nature of the industry. Purchasers of unmanned aircraft insurance will want to carefully analyze their unmanned aircraft insurance needs and work closely with a broker familiar with the unmanned aircraft insurance marketplace to find a suitable carrier. Oftentimes, buying insurance coverage for specialty risks such as these requires buyers to understand the trade-offs involved with the coverage available at a price they can afford.

1. Gillian Yeomans, *Autonomous Vehicles, Handing Over Control: Opportunities and Risks for Insurance*, Lloyds Exposure Management (2014). *See* https://www.lloyds.com/~/media/lloyds/reports/emerging%20risk%20reports/autonomous%20vehicles%20final.pdf.

LIMITING RISK OF LIABILITY AND DAMAGES EXPOSURE THROUGH THE PURCHASE OF INSURANCE

To help understand the need and complexity around unmanned aircraft-specific insurance coverage, we offer the following scenario: Imagine that a videographer operating an unmanned aircraft has bought a standard one million dollar liability policy to cover himself if the unmanned aircraft fails or crashes at a spectator event. The unmanned aircraft crashes and hits an Olympic skier causing a serious, career-ending injury. The skier sues the unmanned aircraft operator for the loss of future earnings from endorsements amounting to millions of dollars and obtains a judgment against the unmanned aircraft operator. Alternatively, the unmanned aircraft merely gets in the way of the skier, adversely affecting performance and resulting in a lost medal and loss of revenue from future endorsements. Although difficult cases to prove, the likelihood of the unmanned aircraft operator being sued is possible, and even if the suit is unsuccessful, the legal defense costs of the operator may or may not be covered under existing policy language.

Where to Start—Identifying Key Risks

Darryl Jenkins, an analyst for the Aviation Consulting Group, set the scene when he said, "Insurance is the 800 pound gorilla in the room no one is talking about." Jenkins asserts: "While FAA integration is a sufficient event . . . insurability is a necessary event before businesses can successfully use UAS [unmanned aerial systems] in the National Airspace System . . . because no business is going to want to be on the line for the liability concerns."[2] He concludes, "Insurability will determine which sectors of the UAS market will grow and which will die."[3]

We know that the commercial use of unmanned aircraft will be a highly regulated industry, of significant concern to insurance underwriters. The FAA has said, "as safety is our top priority, UAS integration must be accomplished without . . . decreasing safety . . . or placing other airspace users or persons and property on the ground at increased risk." The FAA has identified another insurable risk as well: "While the expanded use of UAS presents great opportunities, it also raises questions as to how to accomplish UAS integration in a manner that is consistent with *privacy and civil liberties considerations*." (Emphasis added.)[4]

2. Brianna Ehley, *What's Grounding the Commercial Drone Industry?*, The Financial Times (May 21, 2013), http://www.thefiscaltimes.com/Articles/2013/05/21/Whats-Grounding-the-Commercial-Drone-Industry.

3. Helicopter Association International, *Insurability of UAVs: The "Gorilla in the Room,"* Rotor News (Aug. 21, 2013), http://www.rotor.org/Publications/RotorNews/tabid/843/articleType/ArticleView/articleId/3393/Insurability-of-UAVs-The-Gorilla-in-the-Room.aspx.

4. U.S. Department of Transportation, Federal Aviation Agency, "Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap" First Edition – 2013,

With respect to safety, air traffic control for unmanned aircraft will be a major factor in the speed at which commercial unmanned aircraft can be deployed on any significant and routine basis. Reportedly,[5] NASA researchers are developing an unmanned aircraft traffic management program that would, in effect, be a separate air traffic control system for things that fly low to the ground—around 400 to 500 feet for most unmanned aircraft. As controller of the skies, the FAA would have to sign off on any unmanned aircraft management system. Insurers will require assurances from insureds that requirements and obligations imposed on operators by whatever system of regulations and management is put in place are met.

Operational aspects of unmanned aircraft, all on their own, present serious risks to consider when underwriting unmanned aircraft insurance. Unmanned aircraft can be operated through communication with a pilot sitting in a ground station, but many will have autonomous capabilities where the aircraft will operate on their own. They will operate through advanced software systems coupled with sensing hardware and GPS navigation packaged in a highly maneuverable airframe. A key feature will be an autonomous anticollision system to protect the unmanned aircraft from collisions. They must be designed to handle lost links, in which communications are cut off and the unmanned aircraft must make decisions alone. In addition, depending on the type of unmanned aircraft, they will likely be gathering, storing, and transmitting a variety of data. As unmanned aircraft pivot through the national airspace, all of these computer and electronic communication-driven systems are exposed to all manner of cyber risk as well.

From an insurance point of view, then, unmanned aircraft risks fall into three broad categories that define the important directions in which unmanned aircraft insurance products must evolve: aviation safety, privacy, and cybersecurity. Those needing to limit these risks will include owners, operators, designers, programmers, manufacturers, distributors, component vendors, and end users. Insurers will be in a position to facilitate the transfer of the risk of operating unmanned aircraft, encourage high safety standards, assist in laying the groundwork for adequate regulation, and participate in determining how much testing and verification is required for public availability of UAS.

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http://www.faa.gov/about/initiatives/uas/media/UAS_Roadmap_2013.pdf.

5. Conor Dougherty, *Drone Developers Consider Obstacles That Cannot Be Flown Around*, New York Times, September 1, 2014, http://www.nytimes.com/2014/09/01/technology/as-unmanned aircraft-technology-advances-practical-obstacles-remain.html?_r=1.

UNMANNED AIRCRAFT INSURANCE OVERVIEW

The length of the application to buy insurance, the amount of the deductible, and the cost of the policy are usually good guidelines to determine the scope and breadth of the coverage afforded under a policy. Long applications that ask detailed underwriting questions typically offer better coverage because the insurance company is able to more accurately qualify the risk. If the application and underwriting process is short, coverage is likely to be restrictive with significant conditions and exclusions.

Large commercial businesses with unmanned aircraft operations will likely find more options for coverage and limits than small companies and individuals who are not likely or capable of paying higher premiums for unmanned aircraft insurance. When buying unmanned aircraft insurance, it will be important to take the time to read specimen insurance policies, which brokers provide clients prior to making the purchase. Brokers have a responsibility to discuss the various coverages and restrictions with their policyholders to help them make informed decisions.

As unmanned aircraft become more pervasive in the market, more insurance companies will consider offering broader-based insurance policies designed to include aviation safety, privacy, and cyber risk protection. Insurers such as AIG and Lloyd's of London have a competitive advantage given their appetite for emerging risks and underwriting expertise on staff.[6] As unmanned aircraft operation historical data develops in each of these lines of risk, early market entrant underwriters will be able to use that data to suggest best practices behavior, provide good advice to operators, manage their own exposure, and price risks more accurately.

New insurance companies entering the unmanned aircraft insurance market will see opportunity, but will rightly take a cautious approach to offering coverage. They will have a limited appetite and will offer coverage that will be both restrictive and limited in scope by including strategies to restrict the amount of coverage for certain types of loss events (using sublimits to cap liability in specific situations) or by including exclusions to deny coverage for certain types of events. They may also seek to develop detailed underwriting questions to assess the enterprise risk of unmanned aircraft and may require the operator to meet more stringent conditions or engage in specific business practices in order to keep coverage in force. As more insurance companies enter the unmanned aircraft insurance market to offer coverage, enterprises will need to evaluate different coverage forms from different insurers to find the best fit at the best price for their situation.

6. London Underwriters also have the capacity and expertise to work with companies to custom tailor an insurance policy that specifically meets the needs of the policyholder seeking coverage. Custom tailored policies (called "bespoke" policies) allow a company to propose their risk story to underwriters, and together they work through what the important coverages are and craft a policy to suit the needs of the enterprise.

MARKET OVERVIEW

A nascent but growing insurance market provides limited unmanned aircraft insurance coverage to consumers and businesses today. Aviation insurers have been the first to market with insurance policies for unmanned aircraft. These policies are predominantly focused on the legal liability conditions arising from the use of flying remote-controlled aircraft or unmanned aerial vehicles (UAVs).

But a new generation of unmanned aircraft is flying in new territory with sophisticated onboard systems capable of capturing, storing, and transmitting vast amounts of data and information. These devices are entering the market at a time when laws and cases are struggling to define operating protocols; this creates underwriting uncertainty. Insurers offering coverage to help manage unmanned aircraft risks face not only operational and failure risk but also regulatory uncertainty and exposures arising from emerging technologies that are subject to significant vulnerabilities.

Aviation and cyberinsurance underwriters are likely to compete for this new emerging market since underwriters will need to price both "aircraft type safety" as well as "technology oriented data security and privacy concerns." FAA regulations and guidelines, new constitutional and privacy law cases, state and local attempts to manage and regulate unmanned aircraft, and autonomy and operational component vulnerabilities form a cluster of forces which will affect how underwriters draft policies, underwrite premiums, and handle claims.

Operators of flying unmanned aircraft need to buy liability insurance for when an unmanned aircraft fails and causes a loss. Companies looking to buy liability protection find very few insurance companies willing to offer them broad flight risk coverage that includes today's data risk and cyber exposure. So far, insurers that offer coverage in 2015 provide full coverage for the unmanned aircraft while in flight, loss or damage to the aircraft and associated electronic equipment, replacement of incompatible software following a loss, costs to investigate repairs to damaged equipment, and public liability insurance—personal injury and property damage cover for businesses.

Underwriters look at the number of hours of operation, the experience of the operator, and permission or certification compliance. Underwriters may require the insured to take security measures to protect the unmanned aircraft when unattended. Exclusions are many, and several key risks are not otherwise explicitly covered.

Today's aviation insurers have a good foundation of insuring flight risk and offer important coverage to protect operators, but they fall short of insuring many types of other risks that operators should consider when making an insurance purchase.

While some insurers are offering coverage for unmanned aircraft, observers do not expect the market to really take off until regulations are finalized by the FAA. Aviation practice leaders at major brokerages such as Marsh and Aon are excited by the potential uses of unmanned aircraft and the market that they could create. Michael J. Kerwin, Vice President of Analytics at Avemeo Insurance, an aviation insurer, anticipates a "fantastic" market for unmanned aircraft insurance "once the FAA and local governments figure out how they can safely allow people to monetize such aircraft."[7]

COVERAGES AND UNDERWRITING PRACTICES

Insurance coverage is frequently described in terms of first-party and third-party coverage. The most familiar coverage is third-party: You are liable for damage to someone else (a third party). First-party coverage applies when you or your unmanned aircraft are damaged.

Commercial Unmanned Aircraft Liability Coverage Scope

Property Damage

Commercial owners or operators of unmanned aircraft liability policies should seek coverage for both first-party and third-party property damage. The policy should cover first-party claims for damage to the unmanned aircraft itself and third-party coverage for damage to the property of others, including both fixed property, such as buildings, homes, and land, and mobile property, such as automobiles, livestock, and other tangible objects.

Personal Injury and Third-Party Loss

The liability section of the policy should provide an owner or operator with liability coverage for personal injury to themselves and others, as well as third-party liability coverage for damages arising out of privacy intrusions, security breaches, and communication network failures.

Data Liability

If the unmanned aircraft has the potential to collect, store, or send data, an unmanned aircraft owner or operator should seek liability coverage for damages arising out of the capturing or transmission of personally identifiable information/personal health information (PII/PHI), nonpublic personal information (NPPI), business PII, and NPPI (intellectual property, trade secrets, confidential or sensitive data, and location data).

7. Judy Greenwald, *Insurers Await Influx of Drones Pending FAA Rules*, BUSINESS INSURANCE, May 2014.

Other First-Party Coverages

Depending on the commercial enterprise deploying the unmanned aircraft, owners or operators may want to consider seeking first-party coverage for business interruption, unmanned aircraft loss of use or replacement costs, reputational loss (future earnings), data breach investigations and notification costs, and crisis management costs such as public relations expense.

Exclusions

As in most liability policies, underwriters are likely to exclude from coverage violations of law, criminal or malicious acts, gross negligence, acts of nature or *force majeure*, and terrorism. Numerous other exclusions may be added to these policies and should be carefully reviewed to be sure they do not remove key coverage of importance to the purchaser.

UNIQUE COMMERCIAL UNMANNED AIRCRAFT DATA PRIVACY AND CYBER RISK ISSUES

Coverage

Unlike most commercial manned aerial vehicles, today's unmanned aircraft may be outfitted with an array of software, sensors, and cameras to capture large amounts of data. This creates risks related to the software running the systems and the data captured during unmanned aircraft operation. Also, most unmanned aircraft will communicate with a cloud for remote communication and computational processing of information, creating additional unique risks that must be evaluated.

The Data

In standard property and liability policies, tangible assets consisting of physical objects or real property are a key policy language cornerstone. In those policies, digital data, however, is considered to be an intangible asset and is typically excluded from coverage. The new generation of unmanned aircraft liability insurance needs to provide coverage for emerging risks related to digital data.

Unmanned aircraft insurers will need to have experience qualifying and managing these types of risk and will likely turn to cyber insurance experience to blend underwriting talent with aviation underwriting. Combining these two areas of discipline will improve an insurance company's chance of entering the market safely and confidently.

If the unmanned aircraft to be insured has the potential to collect, store, or send data, an unmanned aircraft owner or operator should seek liability coverage for claims arising out of the capture, storage, and transmission of personally identifiable information/personal health information (PII/PHI), nonpublic personal information (NPPI), business PII, and NPPI (intellectual property, copyright, trademark, trade secret, confidential or sensitive data, and location data). Such claims would include libel, slander, invasion of privacy, copyright or trademark infringement, and misappropriation of advertising ideas, resulting in a blend of privacy and media liability.

Software failure to perform as intended could cause an unmanned aircraft to crash, resulting in personal injury or physical damage. Software can also fail by becoming corrupt, losing connectivity, or crashing, sometimes wiping or rendering itself unusable. The software could mistakenly send legally protected data to an unintended recipient, resulting in breach notification liability. Software data in transit could be hacked by a criminal who steals the data, or the unmanned aircraft itself could be hacked and taken over remotely. Hackers could also gain access to video, camera, or other sensor feeds and use the information gained to commit other crimes. Owners and operators of unmanned aircraft will need coverage for these risks as well.

The Cloud

As society moves toward the concentration of information and processing into cloud-based systems, new and highly complex risk scenarios emerge. Aside from the always-on dependency of an unmanned aircraft's need for Internet connectivity and the fail-over protocols required to complete tasks and avoid risk, the cloud introduces a host of new risks to unmanned aircraft operation that could give rise to liability exposure.

Intelligent infrastructure and artificial intelligence (AI) software is a significant development that will be a game-changer for determining who's liable for unmanned aircraft-related losses. Most unmanned aircraft will have onboard software hard-coded to perform a variety of tasks and functions. Many unmanned aircraft, however, will supplement their communication with cloud-based information that will push out instructions or commands to perform specific, semispecific, or learn-as-you-go tasks. These commands will come from databases of instructional applications.

Most commands will be preprogrammed with a variety of software applications. In application-based modular software programming, core software code underlies a platform that other software applications can run on and offers a dynamic palate of information that enables devices (such as unmanned aircraft) to receive up-to-date programming to perform new and specific tasks.

These tasks can relate to (a) performance (to optimize flight, landing, payload pick up or drop off), or (b) service (to take pictures or video of designated objects, track a person or vehicle, identify an address for destination). The programming may also include AI-based instructions to allow the unmanned aircraft to learn new things as part of their priority instruction (relay flight performance as it is impacted by weather conditions, relay traffic patterns to avoid congestion that may impact a delivery schedule, relay situational performance feedback for analysis and fine-tuning).

An exemplary headline grabbed the attention of the public: "The Robo Brain Project Wants To Turn the Internet Into a Robotic Hivemind." According to the article, "The goal is to create a centralized, always-online brain for robots to tap into. The more Robo Brain learns from the Internet, the more direct lessons it can share with connected machines."[8] This kind of functionality could align perfectly with unmanned aircraft communication and expand the utility of unmanned aircraft to develop great commercial opportunities. Such an uber instruction concept raises significant risk and risk allocation questions which would directly impact underwriting and coverage decisions for insurers.

Preliminarily, for example, if unmanned aircraft are drawing instructions via the cloud from the Robo Brain, the means used to determine if the instructions gathered by Robo Brain are accurate, complete, correct, or even appropriate for any given unmanned aircraft to use for the particular purpose intended will be a critical component to evaluate the potential level of risk. In addition, a key issue will be to whom responsibility should be assigned if flawed instructions are deployed and result in damage to people, property, privacy, or even the unmanned aircraft itself.

Other risks and potential liability exposures will arise, for example, if one unmanned aircraft's source code is infected with malware and through the cloud ALL of the devices become infected, or if corrupted, poorly written, or inadequately vetted software code is created, uploaded into the cloud, and disseminated to a fleet of unmanned aircraft causing adverse outcomes in unmanned aircraft operations. The gathering of data by unmanned aircraft has already raised questions of liability exposure for violations of personal privacy, intellectual property, or trade secret laws. Operators, for example, could be liable for royalty fees or fines for the unauthorized dissemination of intellectual property, intentionally or unintentionally, collected during use of an unmanned aircraft. Depending on the unmanned aircraft's construction, operation, deployment, and use, thousands of variables could impact the risk evaluation calculus.

As mentioned above, AI programming allows unmanned aircraft to perform both limited tasks and functions on their own. AI also enables unmanned aircraft to pull information from databases, integrate those commands, and learn how to perform tasks and functions on the fly. The range of limited tasks is far reaching, from specific A to B functionality to "do A, not B, if C happens."

The growing interest in enabling AI to learn on their own and become more human, however, adds another level of risk complexity. Behavioral optimization

8. Erik Sofge, *Robo Brain Project Wants to Turn the Internet into a Robotic Hivemind*, POPULAR SCIENCE (AUG. 25, 2014), http://www.popsci.com/blog-network/zero-moment/robo-brain-project-wants-turn-internet-robotic-hivemind.

allows unmanned aircraft to analyze, determine, and mimic human traits from a wide and growing range of attributes such as personality, integrity, empathy, frustration, and ethics.

A discussion emerging in the field of robotic autonomous automobiles illuminates concerns and risks related to unmanned aircraft enabled with AI functionality.[9] An article from *Wired* explains: "The way this would work is one customer may set the car (which he paid for) to jealously value his life over all others; another user may prefer that the car values all lives the same and minimizes harm overall; yet another may want to minimize legal liability and costs for herself. Other settings are also possible. Philosophically, this opens up an interesting debate about the oft-clashing ideas of morality vs. liability. The issue of "selectable ethics AI" will undoubtedly be important to the debate about unmanned aircraft deployment and who will be held responsible when unmanned aircraft go wrong, or when an unmanned aircraft "gets mad" or perhaps "goes mad."

Cloud Architecture

Simply put, cloud architecture *includes* an information database made up of tens of thousands of applications that are designed to integrate and communicate with one or many parties. Rudimentarily and conceptually, this would arguably shift liability from a person to a thing. If the software fails, is corrupted, hacked, or taken over, and the unmanned aircraft becomes compromised, is a person or entity liable for any damage or loss that may result from the software risk? Technically, one could argue, the unmanned aircraft would be acting on its own if it is able to retrieve and execute commands without direct human intervention. With so many points of potential failure in the communication chain-of-trust, there surely will be failures, and the results could be catastrophic and systemic. Insurers face an enormous challenge in the effort to devise viable risk transfer products and adequate pricing for exposures of this potential scale, especially in an environment where regulation, laws, and their interpretation lag behind innovation.

Key issues arise from the emerging cloud communication infrastructure, including how minimum standards will be set, who will set them, the legal implications of those standards, who vets the software which operates unmanned aircraft, how the software is vetted, and how standards will be monitored and enforced.

Cloud architecture includes two primary options for cloud-based communications: closed-based systems or open-based systems. Closed-application clouds are cloud-based environments whereby application developers and their app products

9. Patrick Lin, *Here's a Terrible Idea: Robot Cars with Adjustable Ethics Settings*, by WIRED (Aug. 18, 2014), http://www.wired.com/2014/08/heres-a-terrible-idea-robot-cars-with-adjustable-ethics-settings/.

are subject to a strict set of development protocols, standards, and procedures that are governed, vetted, and approved by company oversight. Companies that manage closed-cloud systems police the actions of application performance and specifications, and can remove or shut off applications that do not meet the company's guidelines. (Apple's App Store is an example of a closed-based system.)

Open-application clouds are typically operated by a parent company that allows app source code to be made available to users so they can modify or alter the code to do different things. Many users who favor open architecture app environments make significant improvements to underlying code that can fix bugs, improve performance, add features and functionality, and share these new developments with others in the community. (Google's App Store is an example of an open-cloud system.)

Typically, parent company operators of open-cloud systems are less stringent in policing application market environments for good and bad behavior. Although this trend is improving, and more open-source app clouds are setting higher standards of both performance and conduct, the open-cloud concept will always be more risky to users since the underlying code work will be less subject to oversight in a community encouraged to fiddle with code. Open-cloud markets tend to be most sought out by bargain hunters and entrepreneurial or tech-savvy do-it-yourself developers that prefer free software or the ability to modify applications to alter their performance for their own objectives.

Open- and closed-cloud systems each have strengths and weaknesses and variable levels of risk. At this point, it is unclear whether one is safer or better than the other. Both are equally at risk, however, to the inherent vulnerability of heavy reliance on software that can be subject to a wide swath of corruption or utility dysfunction that can lead to individual or cascading risks.

Underwriting

Data privacy and cybersecurity are complex areas of risk for underwriters to understand in order to predict and price premiums for the wide range of evolving possible problems.

Cyber insurance underwriting focuses on the data: the type and sensitivity of the data and intended use; the practices, procedures, and security measures put in place to protect it; owner and operator care, custody, and control of the data; the unmanned aircraft vendor, manufacturer, and component parts suppliers and their care and control of data; and third-party access to on- and off-boarding of data, who will be granted access, and protections against unauthorized access.

For everything from software design and performance to network configurations, providers and cost will be reviewed in the context of the operator's experience and use of unmanned aircraft. Other key factors underwriters will review are Terms of

Service (TOS) and End User License Agreements (EULA) that the operator enters into when using an unmanned aircraft. Many TOS/EULA contracts will likely be written in such a way as to push liability onto the unmanned aircraft operator and away from the supplier, manufacturer, service or software providers, and venue stakeholders. Additionally, data risk can include requests, demands, or compliance orders from law enforcement and other government agencies, which may impose another aspect of operator liability in need of evaluation by underwriters before issuing a policy. Additionally, as noted above, if the data is in the cloud, an extra level of underwriting complexity is added.

As a result of the fast-paced evolution of unmanned aircraft deployment, communication, and functionality, most insurance companies that use static underwriting disciplines will be behind the curve in providing up-to-date coverage for real-time risk transfer if they take the traditional approach to insurability. Short of taking an all-risks coverage approach, by the time an insurance company understands a risk environment, agrees to cover certain risks, files their coverage forms with departments of insurance for approval, imports the underwriting procedures and policy information into their IT system, and pushes the product out to brokers with a marketing campaign, the insurance coverage intent will already *not* cover many of the new risks that will have emerged during that interval.

THE FUTURE: A POSSIBLE ALTERNATIVE MODEL FOR UNMANNED AIRCRAFT COVERAGE

With the wide and growing body of data available for harvest, visualization, and utilization, insurers may well be incentivized to adopt dynamic pricing and risk algorithms to change their methodology and approach to cover the unique commercial unmanned aircraft data privacy and cyber risks by adopting Usage-Based Insurance (UBI) technology and strategy.

UBI allows insurance companies to monitor behavior and price risk on the go. Currently the most widely deployed form of UBI is in the auto insurance market. UBI auto insurance requires automobile drivers to install a monitoring device on their vehicle that captures sensory data from the car, which is reported back to the insurer. The insurer is able to view the data and charge a price for the relative risk based on how the driver operates a vehicle. If the driver brakes hard, brakes frequently, swerves erratically, and speeds regularly, the price for coverage will be higher than if the driver drives in a safer manner.

Millions of automobile drivers around the world have agreed to allow their insurance company to monitor their driving behavior. Clearly, this arrangement results in the insured giving up a significant amount of privacy, not just in how they drive, but where and when. Many skeptics of UBI are quick to point out that UBI enables insurance companies to gather data that could give them greater justification to deny a claim and to adjust coverage mid-policy and instigate price-creep for higher rated activity. These are just a few of many valid considerations that need to be factored into the discussion when contemplating the adoption of UBI in new industries.

Conceptually, however, the UBI approach to insuring unmanned aircraft could be the optimal strategy for insurance companies to offer meaningful coverage for measurable risk. UBI would allow insurers to develop a baseline understanding of the unmanned aircraft platform, monitor the risk environment in which the unmanned aircraft operates, and provide guidance to users on how risk would affect insurance premiums. UBI would also enable insurance companies, based on the analysis of this valuable data, to fine-tune their loss exposure and loss ratios so they can bring critical value to the market by shouldering appropriate levels of risk, making it possible for widespread users to buy insurance and increase the adoption of unmanned aircraft technology.

CHAPTER

15

Risk, Product Liability Trends, and Insurance in Commercial Unmanned Aircraft

A Data Centric Analysis

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"There are risks and costs to action. But they are far less than the long range risks of comfortable inaction."

—John F. Kennedy

The commercialization of autonomous unmanned aerial systems will make autonomous aerial systems pervasive and ubiquitous across the national airspace within the next few years. Yet even today with a highly limited number of unmanned aircraft operating in restricted airspace, accidents are making national news, including ones with fatalities and property damage. How can unmanned aircraft operators and unmanned aircraft manufacturers protect themselves from risk and liability once commercial operations intensify across many industries?

Unmanned aircraft are essentially robotic aircraft. They can be operated with a pilot sitting in a ground station, but many will ultimately have autonomous capabilities where the aircraft will operate on its own. The FAA currently bans fully autonomous operations but is being pressured to lift this ban as commercial entities develop architectures for autonomous unmanned aircraft operations for business areas such as parcel delivery, medical system emergency delivery, agricultural development, and many more. These autonomous aircraft will operate through advanced software systems coupled with sensing hardware and GPS navigation packaged in a highly maneuverable airframe. A key feature will be an autonomous anticollision system that must not only protect the unmanned aircraft from collisions with other unmanned aircraft but also protect it from collisions with birds, other aircraft, buildings, and structures.

The risks of crashes and incidents caused by unmanned aircraft in the national airspace are currently unknown. Risk profiles have yet to be determined due to the lack of available information. Insurance carriers may be able to extrapolate loss experience from the aviation industry but will need to be adjusted for the issues of robotic autonomy in flight, autonomy in collision avoidance, and autonomy in critical issues such as lost links, in which communications are cut off and the unmanned aircraft must make decisions on its own. Issues such as pilot command, sensor operator, and flight management systems will also be prevalent in risk profiles, as unmanned aerial systems operations can range from fully human controlled to fully autonomous, with many different degrees of both occurring in flight operations complicating the risk factors and triggers.

This chapter will discuss commercial unmanned aircraft in the national airspace from both an autonomous robotics and a piloted systems point of view. An original set of data will be presented with analysis based on studies of unmanned military aircraft accidents. These data and subsequent analysis of the data will be applied to the current issues of national airspace integration to help determine liability triggers and trends to help answer insurance underwriting trends and product liability questions. In addition, the chapter will discuss theories of product liability that plaintiffs may assert against unmanned aircraft manufacturers. For instance, plaintiffs may allege causes of action such as strict product liability, negligence, breach of warranty, and the violation of laws against unfair and deceptive trade practices. The chapter will apply these theories to the context of piloted and autonomous unmanned systems. It will also cover methods for mitigating product liability risks.

Finally, the chapter will discuss the unique insurance issues that may arise as commercial owners, manufacturers, and operators of unmanned aircraft seek to limit their risks of liability and damage exposure through the purchase of insurance. The chapter will discuss the current emerging market of available insurance as well as the likely trend of insurance coverage including scope, limits, restrictions, and availability as more unmanned aircraft are deployed commercially and claim experience grows. Both domestic and Lloyd's of London–based markets will be discussed.

THE FUTURE PERVASIVENESS AND RISK CHALLENGES OF UNMANNED AERIAL SYSTEMS

The mandate of the Federal Aviation Administration to integrate unmanned aircraft into the national airspace makes abundantly clear that the era of unmanned aerial systems is upon us. While estimates vary widely, we must assume that the number of unmanned aircraft that will enter and operate in the national airspace will be in the tens of thousands very soon. This includes unmanned systems of all kinds, from large government-operated systems to small personally operated systems such as model aircraft.

Regardless of the size or configuration of the unmanned aircraft, every aircraft that enters the airspace poses a particular danger. A model aircraft, for example, has killed a person in this country,[1] while the use of what is technically classified as an unmanned aircraft has not. So while the legal wrangling over the classification of an unmanned aircraft and which classification the FAA has jurisdiction over lingers, the overarching issue still remains: What are the potential risks and liabilities of operating an unmanned aircraft and how will they affect insurance underwriting trends?

This question is difficult to answer because unmanned aircraft are not flying at the rate that they will be in the near future in the national airspace. Thus, it may take a decade or more to establish accurate liability trends to be able to effectively gauge the true risks and liabilities of unmanned aircraft in the national airspace.

Unfortunately, operators are waiting in the proverbial wings to lift their unmanned aircraft programs off the ground. Major corporations like Amazon and Facebook have not been shy concerning their intended use of unmanned aircraft when technologically and legally feasible. Private operators are already putting their craft into the sky, for fun and future profit, edging as close to the commercial limitations as possible. As a result, the industry does not have time to wait to evaluate long-term liability trends and triggers.

Herein lies the challenge: Is there any accurate data available to assist legal professionals, insurance underwriters, unmanned systems operators, and interested parties now? The approach of this chapter is to study the current power user of unmanned systems, the United States Air Force. This study, while not directly applicable to the

1. A 19-year-old man lost his life while flying a model aircraft in a Brooklyn park due to the aircraft striking his head causing a partial decapitation. *See* http://www.nytimes.com/2013/09/06/nyregion/remote-controlled-copter-fatally-strikes-pilot-at-park.html?_r=0.

commercial and civilian use of unmanned systems, does provide important information about the issues and effects of operating unmanned aircraft over an extended period of time.

Additionally, the study highlights possible and probable issues that may arise in the commercial or civil operation of unmanned systems in the national airspace, since the mishaps in this study are all noncombat flights and directly relate to the operation of the aircraft themselves without issues of malicious external forces at play when aircraft are operated in the heat of battle. The study, therefore, provides an initial level of theoretical guidance and practical applicability to the current integration of unmanned systems into the national airspace.

A FORMAL UNMANNED SYSTEMS MISHAP STUDY

The formal investigation undertaken in this chapter is a study of all U.S. Air Force Class A unmanned aircraft mishaps over a ten-year period, from fiscal year 2004 through fiscal year 2013. The U.S. Air Force defines a mishap as an unplanned event or series of events resulting in death, injury, occupational illness, or damage to or loss of equipment or property, or damage to the environment. It defines a Class A mishap as a noncombat accident that results in a death, a permanent total disability, or damage of at least one million dollars.[2]

The mishap studies in our analysis were of unmanned systems of all types operated by the U.S. Air Force. The accident reports were publically available from the U.S. Air Force Judge Advocate General's Corps Legal Operations Agency Claims and Tort Litigation site.[3]

The mishap reports are distinguished in the study between manned and unmanned aircraft exclusively. All other instances of Class A mishaps such as satellite, missile, ground station, and non-aviation-related mishaps were excluded from the study. Unmanned tethered balloon mishaps were also excluded from the study, as they do not fall into the category of unmanned aircraft but rather of tethered balloons under FAA regulations in U.S. national airspace.

The mishap reports provided by the Air Force are extensive and provide the results of formal investigations into the causes of the mishaps. It must be noted, however, as with all formal mishap and accident reports under 10 U.S.C. § 2254(d), the opinion of the accident investigator as to the cause of, or the factors contributing to, the

2. Air Force Safety Agency. Air Force System Safety Handbook. HQ AFSC/SEPP Kirtland AFB, NM (July, 2000).

3. US Air Force Judge Advocate General's Corps Legal Operations Agency Claims and Tort Litigation (2014), http://usaf.aib.law.af.mil/.

accident set forth in the accident investigation report, if any, may not be considered as evidence in any civil or criminal proceeding arising from the accident, nor may such information be considered an admission of liability of the United States or by any person referred to in those conclusions or statements.

The mishap reports cover the background of the unit operating the aircraft, the sequence of events, the maintenance on the aircraft, the aircraft systems, the weather, the crew qualifications, the operations and supervision of the aircraft, the governing directives, and any other areas of concern. Within the report, the Abbreviated Accident Investigation Board identifies a cause of the mishap by "clear and convincing evidence." Additional contributing factors are presented by a "preponderance of evidence" if applicable. All investigations were conducted in accordance with Air Force Instruction 51-503.[4]

Results of the Air Force Study

The first task of the study was to determine the frequency of manned mishaps versus unmanned mishaps over the ten-year period. The results of this analysis are rather striking and match the commercial news reports highlighting the high incident rates of military unmanned aircraft. For example, the Bloomberg BGOV Barometer statistics indicate that Northrop's Global Hawk and General Atomic's Predator and Reaper have a combined 9.31 accidents for every 100,000 hours of flying time, which is the highest rate of any aircraft of any category and more than triple the Air Force fleet-wide average of 3.03 accidents for every 100,000 hours.[5]

Figure 15.1 demonstrates the results of the study, which clearly show the high accident rates of unmanned aircraft. The solid bars represent all accidents of all manned aircraft in the Air Force while the striped bars represent the unmanned accidents of all unmanned aircraft models. The earlier years indicate a lower rate of mishaps, but this can be explained by the fact that all military services (Army, Navy, Air Force, and Marines) logged more than 500,000 unmanned flying hours in 2008, representing a sixteen-fold increase over 2002[6] due mainly to the advances in technology and the policies of unmanned integration into military operations.

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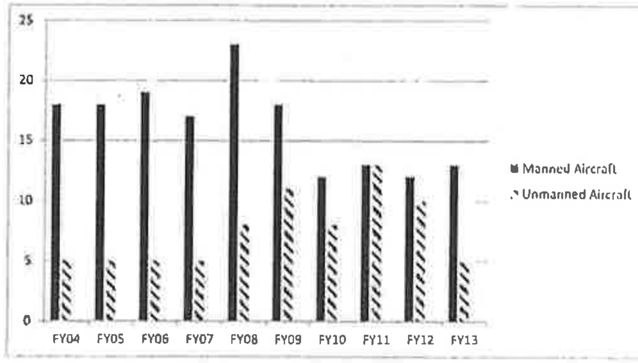
4. Air Force Instruction 51-503. *See* http://static.e-publishing.af.mil/production/1/af_ja/publication/afi51-503/afi51-503.pdf.

5. B. McGarry, *Drones Most Accident-Prone U.S. Air Force Craft*, BGOV Barometer (June 17, 2012), http://www.bloomberg.com/news/2012-06-18/unmanned aircraft-most-accident-prone-u-s-air-force-craft-bgov-barometer.html

6. C. Bowie & M. Isherwood, *The Unmanned Tipping Point*, Air Force Magazine (Sept. 2010), http://www.airforcemag.com/MagazineArchive/Pages/2010/September%202010/0910rpa.aspx.

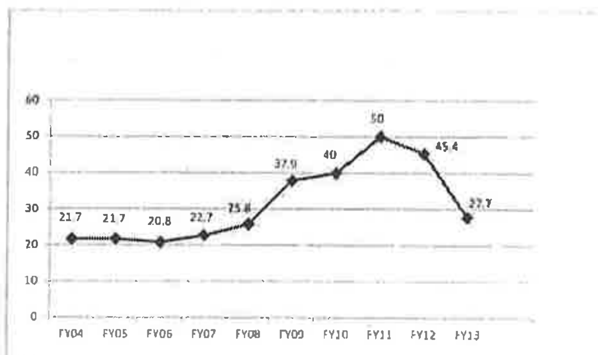
Figure 15.1



Air Force Class A Mishaps Ten-Year Comparison of Manned versus Unmanned Aircraft

Note in particular the fiscal year 2011 when the unmanned and manned mishap numbers were equal. This was the worst-performing year of unmanned aircraft in the study, although fiscal years 2009 through 2012 demonstrate a pronounced increase in unmanned mishaps while manned aircraft mishaps have decreased. To provide a further graphic illustrating the trend of unmanned mishaps, Figure 15.2 demonstrates the percentage of unmanned mishaps in relation to overall manned and unmanned mishaps.

Figure 15.2

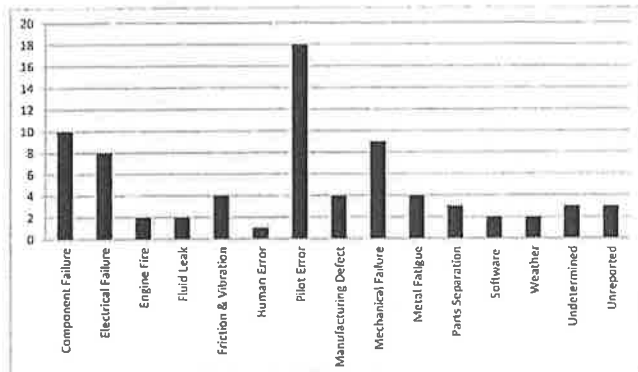


Unmanned Ten-Year Percentage of Class A Air Force Aviation Mishaps

As can be seen, the increased participation of unmanned aircraft in Air Force operations has resulted in a dramatic increase in the percentage of overall Class A mishaps. The fiscal year 2013 provided a respite, with an accident rate just slightly higher than the early integration years of unmanned aircraft. From fiscal year 2004 through fiscal year 2013, there were a total of seventy-five Class A Air Force mishaps, for which seventy-two accident reports or (in the earlier years) accident report summaries were provided by the Air Force Judge Advocate General.

The unmanned aircraft involved in the accidents during the ten-year study were the Global Hawk, the Predator, the Reaper, and the QF and QRF series Target Unmanned aircraft. The causes of the accidents are of critical importance to determine future risk and liability trends. As such, each accident report was carefully examined, including the cause of the accident as well as an analysis of the systems that failed as detailed in each report. Upon analysis, a specific set of categories was developed, and each primary cause was categorized into this set. These data are reflected in Figure 15.3. Aircraft categories were also noted as were the specific systems that were a cause of the mishap.

Figure 15.3



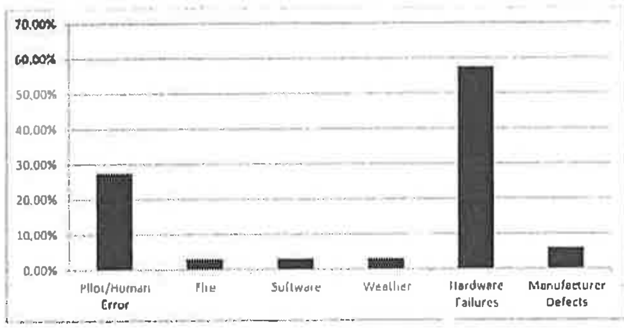
Air Force Class A Unmanned Aircraft Ten-Year Cause of Mishaps

Clearly, pilot error was a major cause of unmanned aircraft mishaps across the decade of the study. The human error category is slightly different in nature and reflects an incident in one of the ground stations where the pilot station throttle was improperly configured between unmanned aircraft models MQ-1 and MQ-9 resulting in an unrecognized command, hence the separate classification.

The aircraft hardware failures were led by individual component failures followed by mechanical failures of parts systems, followed thirdly by electrical failures which included short circuits as well as unexplained power anomalies. Weather was a minimal factor in the mishaps as was system software. In the midrange were metal fatigue and catastrophic damage as a result of friction and vibration. The difference between these two categories is that components in the friction and vibration category were from nonmetal sources or they were a component that was dislodged and jammed into a moving mechanical part resulting in the failure of the system. An example of this was a mishap caused by loss of control due to a partially dislodged computer chip in the right aileron.

Of all of the causes, in summary, pilot/human error accounted for 27.5 percent of the determined and reported mishaps, 3 percent were due to engine fire, 3 percent were due to software, 3 percent were due to weather, 6 percent were due to manufacturer defect in the hardware, while 57.5 percent were due to failure issues with the hardware of the aircraft. These data are represented graphically in Figure 15.4.

Figure 15.4

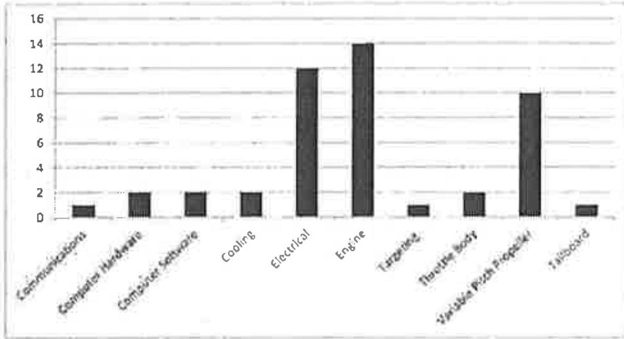


Air Force Class A Unmanned Aircraft Overall Mishap Cause Percentages

To further investigate the mishaps from a systems point of view, the causes were categorized according to the systems of which they were a part. Human and pilot errors, as well as weather and undetermined/unreported factors, were eliminated. Figure 15.5 demonstrates this system point of failure viewpoint.

The data clearly indicate that engine systems failure of various types is a major contributor to unmanned systems mishaps, followed closely by the electrical system, which included the alternator and the electrical circuitry in the aircraft. The variable pitch propeller in each system was also a central point of failure. The multispectral targeting system was the cause of one incident as was the tailboard system and the communications system. The throttle body, which was classified in this study as a separate system, had two incidents, as did the cooling system, which was also classified as a separate system from the engine, slightly dividing out the propulsion system.

Figure 15.5



Air Force Class A Unmanned Aircraft Systems System-Point Mishap Causes

Of note is the low incidence of computer hardware and software causes of failure. The information systems of the mishap aircraft caused relatively few incidents, as both hardware and software had an equal faring in the mishap data. Due to the exponential complexity of software and the dynamics of the software–hardware continuum, this is an overall impressive result. The targeting systems and the communications systems also fared well, causing the least amount of mishaps in the study.

Study Conclusions

The Air Force study has several interesting points. First, weather was a cause in a very minor percentage of the accidents. This indicates the judiciousness of the operators in avoiding poor weather conditions, most likely through advanced meteorological systems provided by the Air Force. Second, computer and software problems were also low, which is a strong indicator of the positive viability of these systems given that they are computationally intensive and driven aircraft systems. Third, the high incidence of pilot and human error indicates training and human factors issues, which affect both the pilots and ground station operators. Finally, the high incidence of engine, propeller, and electrical systems failures indicates pervasive weaknesses in these systems overall that should be noted by future unmanned systems manufacturers and operators.

The study's results are by no means a comprehensive set of statistics for the determination of liability triggers and trends or comprehensive risk assessment. Rather, they serve as a starting point for the discussion. These statistics, combined with those of other services and thereafter combined with statistics generated from future nonmilitary incidents occurring in the national airspace, will give a clearer picture of the issues and risks associated with operating commercial and civilian unmanned aircraft.

PRODUCT LIABILITY IMPLICATIONS OF THE AIR FORCE STUDY

The study above discusses the investigation undertaken to study U.S. Air Force Class A unmanned aircraft mishaps from fiscal year 2004 through fiscal year 2013. The study shows high accident rates of unmanned aircraft and an increase in the accident rate over time, caused by the Air Force's increased use of unmanned vehicles. Figure 15.3 lists the possible causes identified by the Air Force, which the formal study groups into the categories of pilot/human error, fire, software, weather, hardware failures, and manufacturer defects. Figure 15.4 shows the magnitude of the causes attributed to these six categories of causes. Figure 15.5 focuses on the specific systems of hardware causing mishaps, such as electrical, engine, and propeller systems, in comparison with mishaps caused by computer hardware and computer software.

Based on the collected data highlighted above, the formal study points out the high incident of pilot error as a cause of mishaps. As shown in Figure 15.3, pilot error was the most common cause of mishaps. Nonetheless, when all hardware failures are considered collectively, hardware failures as a group are more common as a cause for mishaps than pilot error.

This section discusses the implications of the findings in the formal study from a product liability perspective. It describes the law of product liability and applies the product liability doctrines described to the causes of mishaps. What do the results from the formal study say about a hypothetical plaintiff's chances for succeeding in an action against an unmanned aircraft manufacturer assuming that civilian mishaps resemble the ones experienced by the Air Force? The final subsection of this section analyzes the conclusions we draw from the product liability analysis.

U.S. Product Liability Law as Related to the Study

In general, U.S. product liability law applicable to civilian commercial unmanned aircraft will be state law.[7] As such, the results of one legal case may not be the same as the results of a similar case in a different state. Commercial unmanned aircraft operators and manufacturers must therefore be mindful of each state's specific product liability laws. State law will dictate:

- The causes of action available to a plaintiff asserting a claim against a manufacturer arising out of an accident or other event.
- The essential elements the plaintiff must prove to establish a *prima facie* case of liability under these causes of action.

7. This subsection does not attempt to survey the product liability law of all fifty states and the District of Columbia. Instead, it identifies commonalities among groups of states; it notes majority and minority positions.

- The test the courts apply to determine if a certain product's design is defective.
- Whether the defendant ever has a burden to prove the absence of a defect in a product.
- The role of the plaintiff's conduct as a partial or complete defense to a product liability claim.
- Other defenses available to a defendant.[8]

These state laws may originate from statutes or the common law of torts. Tort law refers to law applicable to wrongs that give plaintiffs the right to seek remedies in a civil action. The common law has evolved over the last decades to create causes of action based on defects in products. Some states codified their common law in state statutory schemes to supersede state common law and implement the policies chosen by state legislatures.

Another persuasive source of legal doctrine is a series of books called *Restatements of the Law*. Judges, lawyers, and scholars in an organization called the American Law Institute write these books and attempt to collect, summarize, and identify trends in the law. Sometimes restatements persuade judges to recognize new doctrines in their individual jurisdictions. For this reason, restatements may change the direction of law. Nonetheless, the doctrines in restatements are not binding on courts when they determine the state of their jurisdictions' laws.

The Strict Liability Cause of Action

Strict liability or strict product liability is the cause of action easiest for a plaintiff to plead and prove against a manufacturer. Courts and legislatures have recognized a strict product liability cause of action in order to spread the risk of product defects and resulting accidents broadly through society and place the burden of managing the risk on manufacturers, rather than on users of the product. The theory is that manufacturers are best able to reduce risk and insure against hazards creating the risk. In the Air Force set of mishap reports, for example, the manufacturer is actively involved in determining the cause of the defect and is therefore quite familiar with the trend of mishaps relating to its particular unmanned aircraft product line. Through this intensive integration into the Air Force accident determination, the manufacturer is in a clear position to improve its product and reduce the specific risks of its products as discovered in the accident investigation process.

8. U.S. federal law may provide additional defenses. One example is the possible preemption of state law causes of action based on a conflict with federal law. Another example is the government contractor defense in which the federal government told the manufacturer to manufacture the product to precise specifications and the product conformed to those specifications despite the manufacturer's warning about the product. As a matter of federal law, the plaintiff cannot maintain a state law action based on a defect arising out of the danger identified by the manufacturer.

The inspiration for a strict liability cause of action is Section 402A of the Restatement (Second) of Torts. Many state supreme courts follow and incorporate Section 402A into state law when establishing common law principles of liability. In turn, states with product liability statutes also track the concepts in Section 402A to create a strict liability cause of action by legislation.

Section 402A says:

> **402A. SPECIAL LIABILITY OF SELLER OF PRODUCT FOR PHYSICAL HARM TO USER OR CONSUMER**
>
> (1) One who sells any product in a defective condition unreasonably dangerous to the user or consumer or to his property is subject to liability for physical harm thereby caused to the ultimate user or consumer, or to his property, if
>
> (a) the seller is engaged in the business of selling such a product, and
>
> (b) it is expected to and does reach the user or consumer without substantial change in the condition in which it is sold.
>
> (2) The rule stated in Subsection (1) applies although
>
> (a) the seller has exercised all possible care in the preparation and sale of his product, and
>
> (b) the user or consumer has not bought the product from or entered into any contractual relation with the seller.[9]

A plaintiff asserting a strict liability claim against an unmanned aircraft manufacturer must plead and prove, under a typical state's law, that the defendant manufacturer sold a product that was "defective" at the time it left the defendant's hands, the product reached the plaintiff without substantial change, and the defect was the proximate cause of the plaintiff's injuries. A product may be defective for one or more of three reasons: (1) the product's design was defective, (2) the product had a defect in manufacture, or (3) the manufacturer failed to warn about a condition of the product.

A defective variable pitch propeller, for example, was the cause of several Air Force accidents. In some of the mishaps the propeller shaft had a design defect which affected the rotation of the shaft over time, while in others there was a manufacturing defect resulting in metal cracks and chips which wore out in operation due to accelerated metal fatigue.

A design defect occurs when the manufacturer fails to design the product to be safe. All copies of that product would be defective. A manufacturing defect occurs when one or a number of copies of the product are defective, even if the design was

9. Restatement (Second) of Torts § 402A (1965).

safe. For instance, if the stamping equipment caused a metal part to be too thin in one section, thinner than the design specifications, the defect arose from the manufacturing process, not the design. Finally, a product may be considered defective in the absence of essential warnings to inform users about certain potentially harmful or hazardous characteristics of the product.

In this subsection, which is based on the formal Air Force study, we are most interested in design defects and failures to warn. Methods to ensure safe manufacturing and uniform quality of completed parts and products are beyond the scope of this chapter.

Different states have different standards for establishing when a product's design is defective. The two main tests for the existence of a design defect are the consumer expectation test and the risk utility test. Under the consumer expectation test, a product is defective if it is "dangerous to an extent beyond that which would be contemplated by the ordinary consumer who purchases it, with the ordinary knowledge common to the community as to its characteristics."[10] For instance, if a consumer purchases a lawnmower and upon first use the blades shatter and fly out the side, that lawn mower is dangerous and does not work in a way that an ordinary consumer would expect.

The risk utility test is somewhat more complex. Under this analysis, a product design is defective if the product's risks outweigh its utility or benefits to users and the public. Frequently, a plaintiff points to an alternative design that makes the product as useful, but would not be unsafe. Another common issue focuses on the manufacturer's ability to reduce the risk of the design without impairing its usefulness or making it too expensive. Most states use the risk utility test for defining design defects. A much smaller number of states permit courts to use either test for defining design defects. A handful of states define a defect solely under the consumer expectation test.

Under some states' laws, once a plaintiff has made out a *prima facie* showing that a product is defective, the burden shifts to the defendant to prove that the product is not defective.[11] This burden-shifting process may play out at trial or in summary judgment proceedings. As a general matter, however, a plaintiff bears the burden of proof in a civil case to prove the essential element of the plaintiff's claim by a preponderance of the evidence, and expert testimony is nearly always required.

The Negligence Cause of Action

Under a negligence theory, a plaintiff would seek to show an unmanned aircraft manufacturer had a duty to exercise reasonable care in designing and/or manufacturing the unmanned aircraft, the manufacturer breached that duty, and thereby proximately caused the plaintiff's damages. A negligence claim is harder for a plaintiff to establish

10. *Id.* § 402A cmt. i.
11. *See, e.g.*, Barker v. Lull Eng'g Co., 573 P.2d 443 (Cal. 1978).

than a strict liability claim, because the plaintiff must prove that the manufacturer acted unreasonably. For instance, a plaintiff may contend that the manufacturer knew or should have known about a design defect, but failed to exercise reasonable care and sold the product anyway despite the defect.

Breach of Warranty Causes of Action

A warranty claim may be based on express statements from the manufacturer promising certain features or characteristics of the product that the plaintiff alleges are false. These express statements may come from advertising materials about the product or other communications by the manufacturer. The law may also imply a warranty that the product will not harm consumers who use the product for its ordinary purposes. This warranty is known as the "implied warranty of merchantability." Alternatively, if the seller knows that the product will be used for a particular purpose, and the buyer is relying on the seller's judgment concerning the fitness of the product, the law will imply a warranty that the product is fit for the contemplated purpose. This warranty is called the "implied warranty of fitness for a particular purpose." If the product does not conform to an implied warranty, a plaintiff could assert a breach of the implied warranty.

In order to prevail under a warranty theory, the plaintiff would have to show the existence of a warranty and a breach of that warranty. In some states, a plaintiff might need to be a purchaser of the product or a household member. Moreover, a plaintiff may need to prove that he or she provided timely notice of the defect to the seller.

Statutory Causes of Action

States have passed various kinds of legislation to protect consumers from unfair and deceptive trade practices of businesses and to give plaintiffs the right to bring suit for violations of statute. Examples include California's Unfair Competition Law (UCL),[12] False Advertising Law (FAL),[13] and Consumer Legal Remedies Act (CLRA).[14] The UCL strikes at any unlawful, unfair, or fraudulent business acts or practices. The FAL bars untrue or misleading advertising practices. The CLRA prohibits a list of unfair business practices, such as misrepresenting the characteristics and qualities of a product.

These statutory causes of action are interesting because a plaintiff can bring a claim even though an accident may not have occurred. A plaintiff could assert that a defect in the product diminished its value. For instance, if the plaintiff purchased a car for $20,000, but the car's defective state meant that the car was worth only $15,000, a plaintiff could assert that the seller sold the car for $5,000 more than it was actually

12. Cal. Bus. & Prof. Code § 17200 et seq.
13. *Id.* § 17500 et seq.
14. Cal. Civ. Code § 1750 et seq.

worth. Under the UCL, a plaintiff could seek restitution of the purchase price (the $20,000) or disgorgement of wrongful profits (the $5,000).

Defense Based on the Conduct of the Plaintiff

All states recognize a defense to a product liability claim based on the conduct of the plaintiff. In some states, a plaintiff's "contributory negligence" in using the product is a complete defense to a liability claim. Other states create a "comparative negligence" regime. Under a pure comparative negligence regime, a defense based on the plaintiff's negligent conduct does not defeat the plaintiff's claim entirely. Rather, the trier of fact (a jury or, in the case of a bench trial, a judge) determines what percentage of the plaintiff's damages were caused by the plaintiff's own conduct and diminish any award to the plaintiff by that percentage. For instance, if a jury found that there were two causes of the plaintiff's total damages of $100,000, a manufacturing defect and the plaintiff's negligent misuse of the product, and said 75 percent of the cause was the defect and 25 percent of the cause was the plaintiff's conduct, the jury would be instructed by the judge to render a verdict for the plaintiff, but award only $75,000 in damages. Some states have a modified comparative negligence regime. Their laws say that if a plaintiff's negligence is 51 percent or more of the cause of the damages, the plaintiff cannot recover at all. If it is less, then the plaintiff's negligence merely diminishes the plaintiff's recovery as described above.

APPLICATION OF U.S. PRODUCT LIABILITY LAW TO THE RESULTS OF THE AIR FORCE STUDY

Having discussed the different causes of action a plaintiff may assert and one major defense a manufacturer may raise based on the plaintiff's own conduct, we now turn to the product liability implications of the Air Force data.

The first result deserving attention is the attribution in Figure 15.3 to a small percentage of mishaps caused by manufacturing defects. We do not have enough information to know if the Air Force used the legal standards applicable to manufacturing defects described above. In fact, common sense suggests that investigators were probably not that precise in identifying manufacturing defects as a cause. Accordingly, the mishaps labeled as such may not have risen to a level sufficient to trigger manufacturing defect liability under the legal theories described above. Moreover, did the term "manufacturing defect" also cover the category of design defect? It is unclear whether these mishaps would have given a plaintiff a successful claim for either manufacturing or design defect.

It is also true that the absence of a designation of "defect" by the investigator does not mean the product would not, in fact, have triggered liability. The nonweather, non-pilot error causes listed by the investigators in Figure 15.4 focused on fire, software failures, hardware failures, or manufacturing defects. The fires, software failures, or hardware failures may have been caused by design or manufacturing defects. Again, there is not enough information about these mishaps to say that a manufacturer would have escaped liability in civil actions based on these mishaps.

In litigation, each side would have experts who would analyze all the information about a given mishap to not only identify the immediate cause, such as a hardware failure, but also determine why the hardware failure occurred. Was the hardware failure caused by a defect in the design, a defect in the manufacture, or some other cause? That other cause may have been ordinary wear and tear affecting a nondefective component. Each product has a life span and needs to be maintained. The failure to replace worn-out components may be the cause rather than a defect or the manufacturer's conduct. The information available for us to study is simply not detailed enough to answer these questions.

One final observation about the study's findings and product liability concerns pilot error. It is apparent that if these mishaps were the subject of civil actions, contributory/comparative negligence would be a key issue in these cases. The pilot's own error was the most common cause of mishaps. Nonetheless, a pilot error does not automatically mean the pilot was negligent. For instance, if the manufacturer failed to design the unmanned aircraft to prevent a reasonably foreseeable use of the unmanned aircraft or action by the pilot that might be erroneous, a trier of fact could find a defect notwithstanding the immediate cause of the pilot's error. There might be an alternative design that prevents the pilot error.

An analogy would be antilock brakes in cars. It is reasonably foreseeable that some people using older braking systems would cause their cars to skid on icy roads. The immediate cause of these accidents might be the driver's failure to pump the brakes properly. However, the alternative design in the form of antilock brakes can prevent skids caused by a driver's failure to pump the brakes properly.

In any case, even the incidence of pilot error does not show that a manufacturer would escape liability if these mishaps were ever the subject of a civil action. Again, the information available in the reports does not provide sufficient information to show whether the pilot that caused the accident acted negligently.

CONCLUSIONS CONCERNING APPLICATION OF U.S. PRODUCT LIABILITY LAW TO THE RESULTS OF THE AIR FORCE STUDY

Although the information in the mishap reports is not very precise, we can at least say that pilot error is a chief cause of the mishaps and raises the prospects of a large incidence of pilot error when unmanned aircraft are used for commercial applications. To manage these risks, commercial entities should train their pilots carefully to prevent accidents. They should also choose unmanned aircraft that are easy to use and have effective interfaces.

Manufacturers should implement risk management practices to reduce the incidence of mishaps caused by the particular components noted. There may be cost-effective engineering controls that could improve safety. Moreover, the results of this study can help them focus on particular components and systems that have proven to be the greatest source of risks. Figure 15.5 shows that the components and systems creating the greatest risk are the electrical components, the engine systems, and the variable pitch propeller. If manufacturers fail to address these system risks, they run the risk that plaintiffs will claim they knew of these potential risks and failed to exercise reasonable care to reduce them.[15]

INSURANCE UNDERWRITING IMPLICATIONS OF THE AIR FORCE STUDY

As noted in the summaries of both sections above, the Air Force study reveals two key findings: Hardware failures caused 57.9 percent of the mishaps studied, and human error or factors caused 27.5 percent. Although from a noncommercial context, these findings carry major significance from an underwriting point of view. The study can help underwriters focus their underwriting decisions based on the purchaser's response to questions relating to potential mishap causes demonstrated to be responsible for creating the greatest risk to the operation of unmanned aircraft.

With respect to both property and liability coverage, key underwriting questions should be directed to identifying and quantifying any specific hardware weaknesses of the unmanned aircraft sought to be insured. Underwriters should also be very concerned with the unmanned aircraft operator: their training, licensing or permitting, and years of experience with respect to aerial vehicles, both manned and unmanned, their experience with the components and systems that comprise and operate the

15. For a more thorough discussion of risk management methods in the manufacture of robots, *see* Stephen S. Wu, *Risk Management in Commercializing Robots* (Apr. 3, 2013), *reprinted at* http://conferences.law.stanford.edu/werobot/wp-content/uploads/sites/29/2013/04/Risk-Management-in-Commercializing-Robotics.pdf.

unmanned aircraft, as well as their understanding of privacy and data liability issues affected by the management, security, and protection of the unmanned aircraft and any data it gathers or uses for any purpose.

Property Damage

To determine whether to offer property damage coverage and at what premium, insurers will evaluate the type of unmanned aircraft, its design, including weight, range, capacity, payload, power train, and other onboard operational systems. They will also evaluate the costs of the unmanned aircraft, including repair, replacement, upgrades, and maintenance. The study suggests underwriters should pay particular attention to the quality of the electrical, engine, and propeller systems. Aviation insurers offering unmanned aircraft coverage are starting the underwriting process with applications typically used for manned aerial vehicles adapted for unmanned aircraft.[16] The more sophisticated the unmanned aircraft or its use, the more detailed information underwriters will seek in order to most accurately quantify the risk.

Liability

For liability risk underwriting, insurers will evaluate the type of unmanned aircraft, intended uses, and venues in which it will be operated or used. They will take into consideration whether the unmanned aircraft will be operated in urban or nonurban environments, from or over transportation arteries or densely populated areas, on or near waterways, in what airspace, and under what legal authority.

Underwriters will pay close attention to the legal requirements for use of the unmanned aircraft(s) to be insured and the insured's ability to comply with them, including unmanned aircraft licensing and permitting, authorized situational environments, and attendant duties of care. Whether the anticipated risks to be underwritten are negligence, strict liability, or ultrahazardous activities will affect premium, scope of coverage, and potential exclusions.

Unmanned Aircraft Manufacturer Liability Insurance Coverage

The good news is that there are reasonably substantial insurance policies available to unmanned aircraft manufacturers. The bad news is that these policies rarely cover any risk for data privacy or cyber liability. Limits are available, however, up to $100,000,000 and more with worldwide coverage territory. Nevertheless, the study suggests underwriters of this type of insurance should also pay particular attention to the quality of the electrical, engine, and propeller systems used by the manufacturer.

16. *See*, for example, Kiln Group Aviation Division UAS OPERATORS INSURANCE PROPOSAL FORM offered through the Unmanned Aerial Vehicle Systems Association at http://www.uavs.org/document.php?id=168&ext=pdf.

CONCLUSION

Unmanned aircraft will become ubiquitous in the national airspace. At the same time, issues of risk and liability will move to the forefront as manufacturers and operators face significant challenges arising from aircraft operations. The risks and challenges will only increase as unmanned aircraft used in the skies become the norm rather than the exception.

Product liability issues will inevitably generate litigation, with causes of action such as strict product liability, negligence, breach of warranty, and the violation of the laws against unfair and deceptive trade practices facing all manufacturers of unmanned aircraft and their component parts. Insurance issues will also move to the forefront, as commercial owners, manufacturers, and operators of unmanned aircraft seek to limit their risks of liability and damage exposure through the purchase of insurance. Thus, through proper analysis, risk management, and observations of the liability and risk trends and triggers, stakeholders in the unmanned arena will be well equipped to handle the emerging unmanned systems market. The unmanned systems future is well on its way.