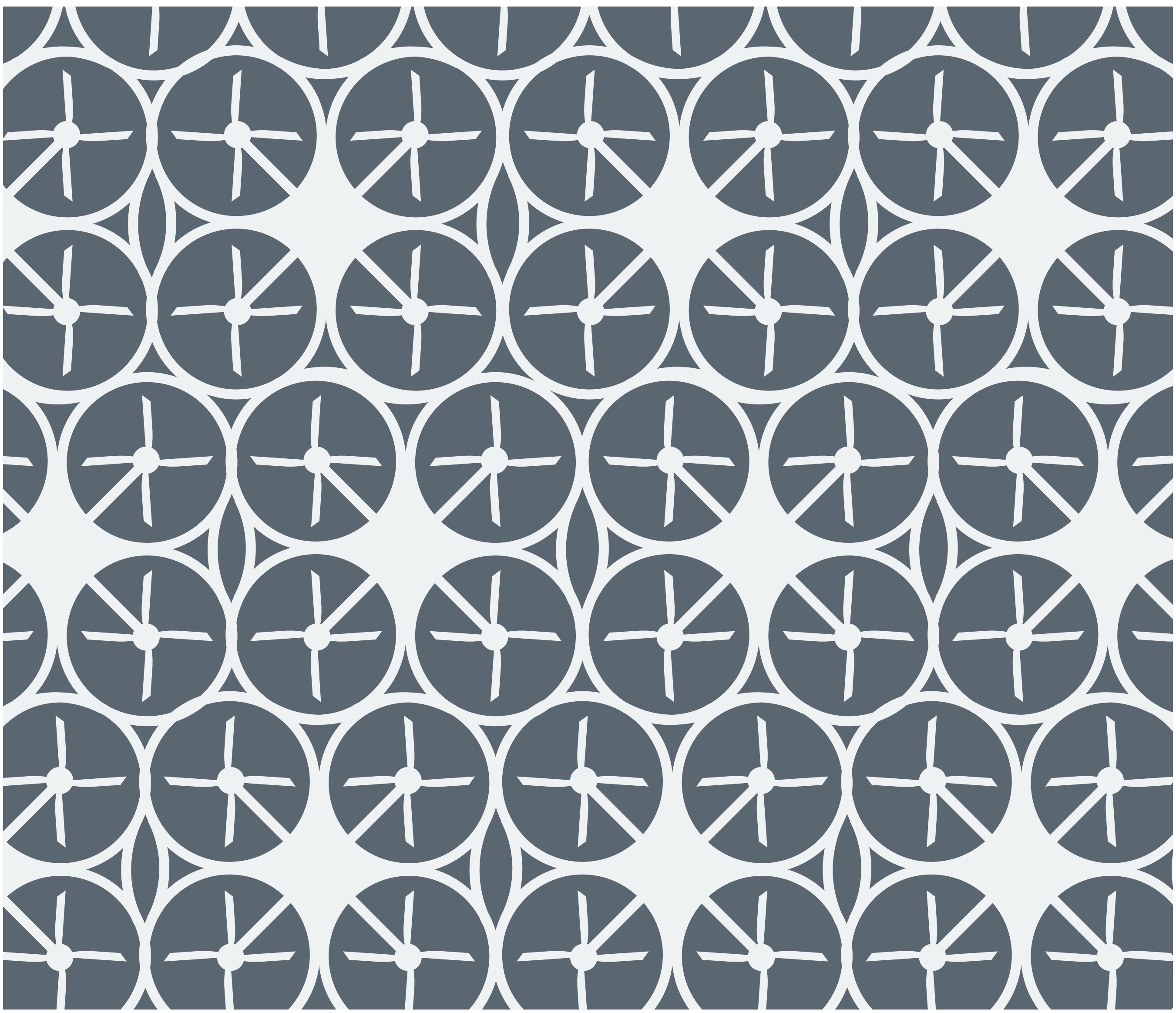
MARSH

INSIGHTS | June 2015

Dawning of the Drones: The Evolving Risk of Unmanned Aerial Systems



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INTRODUCTION

Growth projections for the drone or unmanned aerial system (UAS) sector are nothing short of phenomenal, as the opportunities and advantages afforded by using this type of machinery become more apparent. Regulators around the world have initially struggled to embrace and regulate this new technology. However, some progress is finally being made, as regulators weigh the potential benefits of using drones against issues surrounding privacy and national security.

Meanwhile, the insurance industry is responding to demand at its own pace. While capacity remains plentiful, over-subscription is coming to the aid of the new startups in this class as insurers seek new ways to bolster their balance sheets. Expertise and historical data (unlike capacity) are not super-abundant; however, insurers are eagerly testing the waters of this dynamic industry. To do this, they are using their experience of the manned class to assess the risk and/or limiting their exposure by selection against size, uses, and values of the aircraft, or the type of coverage offered.

In 10 years, it is estimated that 10% of the global civil aviation fleet will be unmanned[1].

Annual global spending on unmanned aircraft is expected to double to US$11.5 billion by 2023[2].

In 2015 alone, more than 1 million UASs are expected to be operated commercially[3].

1. *A New Era for Aviation: Opening the aviation market for civil use of remotely piloted aircraft systems in a safe and sustainable manner*, European Commission, Brussels, 2014.

2. "Unmanned Aircraft Systems," Federal Aviation Administration, available at https://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/aerospace_forecasts/2013-2033/media/Unmanned_Aircraft_Systems.pdf, accessed on 1 April 2015.

3. *Technology, Media & Telecommunication Predictions 2015*, Deloitte, avaiable at http://www.deloitte.co.uk/tmtpredictions/, accessed on 1 April 2015.

CHALLENGES

While UAS use has increased dramatically in recent years, several issues remain, ranging from privacy concerns to insurance considerations, that currently limit UAS applications.

REGULATION

Regulation is undoubtedly the greatest barrier to widespread UAS use, as regulators worldwide attempt to keep pace with this new technology — so much so, that we dedicate an entire section to the issue later in this report. Clear and harmonized regulation would enable startup operations to plan with certainty, public perception to improve, and entrepreneurs and businesses to expand without feeling held back by "red tape." This, in turn, would fuel the growth and experience of this type of aircraft.

INSURANCE

The majority of manned aircraft operators in countries around the world are required by law to hold adequate levels of insurance in order to meet their liabilities in the event of an accident. At present, the situation for UAS operators is not as clear.

We explore the issue of insurance in greater detail in the next section of this report.

SPOTLIGHT

Worth the Trouble

Establishing suitable national and international regulatory frameworks for UASs to safely operate will undoubtedly be complex and time-consuming tasks. Nevertheless, the potential economic benefits are considered to be vast. In March 2013, the Association for Unmanned Vehicle Systems International estimated that integrating UASs into US airspace alone would have an economic benefit worth more than US$13.6 billion and create in excess of 70,000 jobs in the first three years. By 2025, it estimated this could reach US$82 billion and 100,000 jobs.[4]

4. *The Economic Impact of Unmanned Aircraft Systems Integration in the United States*, available at http://www.auvsi.org/econreport, accessed on 1 April 2015.

Integrating UASs into US airspace alone would have an economic benefit worth more than **US$13.6B.**

FAMILIARITY AND PUBLIC PERCEPTION

While public perception is shifting (particularly in countries where it is possible to purchase UASs for recreational use), there is still an element of fear that is linked inextricably to issues surrounding autonomy, privacy, and military operations.

Without solid regulation, confidence in these aircraft is likely to remain low. However, the public perception of how UASs are applied could change, for example, in the way they have been used in the developing world and in disaster relief scenarios. Developing nations are not only open to cost-efficient ways of transporting goods to disaster relief areas, they also see the growth opportunities that such technological breakthroughs represent.

SENSE-AND-AVOID TECHNOLOGY

A key barrier to the large-scale commercial use of UASs is the problem of sense-and-avoid technology.

At present, commercial UAS operations are relatively low-scale, visual line-of-sight (VLOS), which require user input to guide them over and around static or other airborne objects. Even then, the possibility of a wind gust or an erroneous user input does not rule out collision completely.

Sense-and-avoid technology is an integrated set of sensors and avionics designed to enable a UAS to see and avoid obstacles in its path. The commercial application of such technology is essential to guarantee more complicated, yet safe, commercial beyond-line-of-sight (BLOS) UAS operations at low altitudes within civilian airspace.

A number of companies are presently working on this technology and some have succeeded. The ultimate goal of producing a large-scale sense-and-avoid system that provides autonomous collision avoidance for BLOS operations, however, remains several years away.

TRAINING/ENGINEERS

UASs will also require a new generation of aviation engineers to be trained. As the complexity and scale of UAS operations increase, there is a greater likelihood of experience crossing over from the manned sector, but regardless of size, these engineers will need to be conversant in both the vehicle itself and the ground-station technology. Where engineers in the civilian and military sectors may be specialized in airframe, engine (propulsion), or avionics, it is unclear how tomorrow's UAS engineers will be trained and how many of them will be needed to support the sector.

FUNDING

Companies need investors and researchers require funding: While the headline-grabbing Amazon operation clearly has financial backing, sustainability is required to ensure these companies and organizations achieve their goals. The global economy is in recovery but investment in emerging technologies continues to dwindle.

SPOTLIGHT

Imperial College

Dr. Mirko Kovac is director of the aerial robotics laboratory and lecturer in robotics at Imperial College in London. Gaining inspiration from nature, Dr. Kovac and his team apply principles from birds and insects to aerial robotics in order to develop the next generation of UASs and nano aerial vehicles (NAV). The research that Dr. Kovac's team undertakes has far-reaching implications for the insurance industry.

While previous studies have included perching mechanisms for NAV, which allow a fixed-wing glider to attach and detach on command to a vertical landing area, latter studies included grabbing mechanisms where UASs fly and collect items while in flight and "swarming" — its benefits being an aerial team working between multiple UASs. Lately, research has moved to:

1. Combinations of aerial 3D printing and UAS use. Two examples from Dr. Kovac's team: i) To create a landing surface for the vehicle itself; and ii) To create a sticking surface on hazardous waste for a second UAS to pick up.
2. Transfer of UAS from air to (under) water and back to air. This, along with themes in the science of water-sensing (testing for pollution, for example), could revolutionize response to oil spills, pollution monitoring, and disaster response.

INSURANCE

The involvement of the insurance industry in providing coverage for physical loss (hull) and product liability for the production and testing of UASs goes back as far as the late 1980s, when the underwriting community had very little knowledge of these types of aircraft and limited interest in them.

At the time, attempts to understand the risk profile of UASs led to a highly technical risk analysis that resulted in coverage eventually being offered, usually with many subjectivities. These included an agreed number of flight hours to be completed by each vehicle prior to coverage being offered and a significant amount of supporting information being provided prior to underwriters' approval (far beyond manned aircraft data requirements).

UAS risks are currently being written worldwide by Lloyd's markets and companies alike, although appetites are proportional to the comprehension of risk UASs in general, ratings, wording development, and the clients themselves. Despite a lack of data and understanding surrounding many of the risks involved with UAS operations, the market is nevertheless undertaking a brisk pace of learning and development so that it can support this nascent industry.

At present, the largest growth area is expected to be for VLOS operations — particularly for unmanned cargo — that require up to US$1 million physical loss sums insured.

POLICIES/WORDINGS

Traditional coverage is being brought up to date by brokers and underwriters. Where off-the-shelf wordings for manned aircraft exist, most need only tweaks to be applicable for the latest technology or terminology: "aircraft" would become "UAS," "pilot" would become "operator," and so on. Beyond these aesthetics, the debate continues with regard to agreed value versus insured value basis. In recent years, the aviation market has used agreed value under the physical loss section of the policy to reflect the sum insured and, as such, in the event of loss, the agreed value of the aircraft is paid to the client, less any applicable deductibles. While the same formula applies to insured value, the loss will be adjusted to take into account the perceived value of the aircraft at the time. Therefore, as technology advances and these aircraft become obsolete, their perceived value in the eyes of some markets plummets.

SPOTLIGHT

Insurers Filling the Regulatory Breach

In March 2015, a Bloomberg article titled "Insurers Step Up for Drone Pilots Unwilling to Wait on FAA Rules" noted that US-based companies interested in UAS operations are obtaining coverage from insurers that are writing their own safety rules for clients.[5]

Despite the FAA admitting that it is up to two years away from issuing final regulations to govern the use of UASs, during which time none are supposed to fly without a formal waiver, the article stated that several US insurers are already writing policies on thousands of drones across the country.

5. "Insurers Step Up for Drone Pilots Unwilling to Wait on FAA Rules," available at http://www.bloomberg.com/news/articles/2015-03-06/insurers-step-up-for-drone-pilots-unwilling-to-wait-on-faa-rules, accessed on 1 April 2015.

"US-based companies interested in UAS operations are obtaining coverage from insurers that are writing their own safety rules for clients."

What Risks Can Be Covered?

Physical Loss:

- The UAS itself (airframe, propulsion units, operating system, and flight controls).
- The payload (camera equipment, sensors, packages/"slung items").
- The ground station/control unit.
- Spares.
- Transit coverage.

Liability:

- Third parties (bodily injury and property damage).
- Product liability (re-seller or manufacturer, for example).

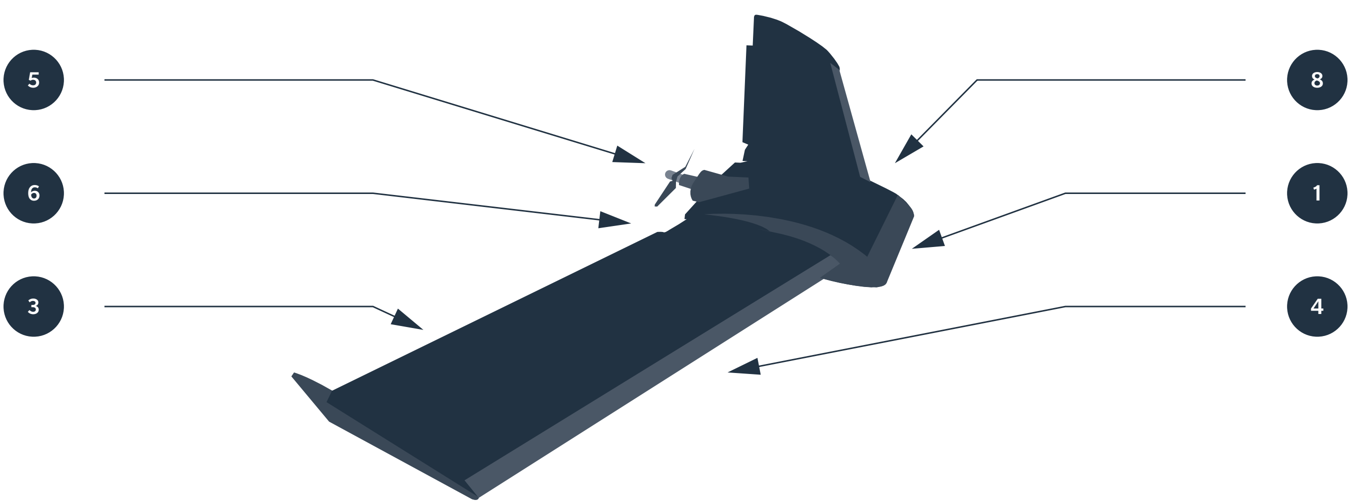
Influencing the Underwriter: How Risk Profile Influences Hull and Liability

ITEM	HULL	LIABILITY
OPERATOR CERTIFIED BY GOVERNING BODY	√	√
HOURS TYPE FLOWN SINCE MANUFACTURE	√	√
SINGLE/MULTI-ENGINE	√	√
ENGINE TYPE/REDUNDANCY	√	√
OVERHAUL LIFE OF THE ENGINE	√	
MEAN TIME BETWEEN MAINTENANCE (MTBM)	√	
CONTROL SURFACE REDUNDANCY	√	
MESSAGE TRANSMISSION OPTIMIZATION MECHANISM (MTOM)	√	
RANGE	√	√
ENDURANCE	√	
LAUNCH AND RECOVERY	√	
AUTONOMY DURING CRITICAL PHASES	√	
RECOVERY TECHNIQUE	√	
NAVIGATION	√	
COMMS	√	
PAYLOAD	√	
HAZARDOUS MATERIALS (HAZMAT)	√	√
GROUND CONTROL STATION (AND NUMBER)	√	√
ATC INTERACTION	√	√
GROUND CONTROL STATION REDUNDANCY	√	√
OPERATOR'S EXPERIENCE	√	√
COUNTRIES	√	√
USAGE	√	√
OPERATING ENVIRONMENT (URBAN/NON-URBAN)	√	√
MAINTENANCE	√	
STORAGE	√	
METHOD OF TRANSIT	√	
SECURITY AND SAFETY OF LOAD WHILE IN TRANSIT	√	

UAS RISKS

Rotary-Wing UAS

Fixed-Wing UAS



1 2 Receiver/Transmitter and GPS

If protruding from the vehicle, receivers and transmitters can be prone to damage; however, most are relatively inexpensive to replace and would fall below market deductibles. Global positioning systems (GPS) are perhaps slightly more expensive to replace, depending upon capability.

3 Airframe

Larger-scale UASs are largely built on the monocoque/semi-monocoque structure style that manned aircraft are built on. Smaller-scale, fixed-wing UASs have employed an expanded foam approach to wings and some fuselage sections, which offers weight and manufacturing benefits. These structures are also incredibly strong. In the rotary-wing sphere, the airframe can be quite girder-esque to look at, and these are largely developed from carbon-fiber material, which offers strength and weight benefits — as with manned aircraft, the airframe is usually the cheapest element to repair and/or replace.

4 Undercarriage

Fixed-wing UASs use "belly landings" and thus undercarriage for them becomes a nonsensical term. That said, if by design they are to be operated in this way, then eventually the area of the UAS (or in some cases the whole airframe) will require replacement. With rotary-wing aircraft, the undercarriage is normally manufactured from the same light-weight carbon-fiber material, although it is designed to take impact loading as well.

5 Propulsion

Most rotary-wing UASs are powered by lithium-polymer (Li-Po) powered motors. On semi-professional equipment, motors can be US$250 each to replace, and while there is no current legislation behind "lifeing" these in the same way that manned aircraft must have engines overhauled or replaced, these are normally vulnerable to damage being incurred on the extremity of the airframe. They can also suffer damage if the propeller units themselves are damaged and transmit load into the motors. For larger UASs, engines would be treated in the same way as manned aircraft.

6 Power

Some smaller-scale, electrically powered UASs use Li-Po batteries. While capable of developing high output, their capacity for long flights is reduced and, therefore, an operator will require a steady supply. One of the biggest issues is not their capacity but their stability; in the manned sector, some airlines are considering banning the transport of lithium batteries, which may have contributed to an in-flight fire that resulted in the crash of a cargo flight in 2010. Powering larger-scale aircraft once again falls into the realm of their manned cousins, with petrol (AVGAS), turbine, and jet engines being used — however, there is no perceived higher risk as a result of their use.

7 Gimbal

The gimbal provides a stable and level platform for camera or other equipment to be seated. Given its precision nature, this equipment can be expensive, even at the bottom end of the scale: A low MTOM rotary-wing aircraft, for example, can carry a gimbal that is worth US$5,000.

8 Payload

Payload effectively refers to the "cargo" of the UAS. While this is discussed in greater detail on page 8, the majority of the risk is derived from the positioning of the payload, since it is traditionally slung beneath or forms part of the underside of the UAS, which could mean it is the first part of the aircraft to come into contact with the ground.

9 Controller

Risk to the controller — which can be hand-held or full cockpit layout (often in a van) — varies depending upon the size/type of control station and functionality. Since most UASs are currently employed in data-gathering functions, the controller itself may have additional equipment for recording images and interpreting data.

INSURER CONSIDERATIONS

SIZE AND WEIGHT OF THE AIRCRAFT

The levels of coverage required, whether by regulation alone, by airport requirement, or client choice, generally increase exponentially with the size and weight of the aircraft. Taking the European Union regulations as an example, where aircraft are obligated to carry minimum levels of liability insurance (as per EU regulation EC785), UASs will also require guidelines and potentially lower limits. The majority of growth in Europe for UAS operations is taking place in the sub-20kg weight category and, as such, EC785 is silent on the application of liability limits. One current school of thought suggests that the kinetic energy displaced during an accident should be used to provide guidance on the required level of coverage. Until this is addressed, however, underwriters may find it difficult to offer the required limits of cover against their clients' requirements, resulting in a disparity between the levels of cover being offered and the premium levels that their clients feel are acceptable.

PAYLOAD

Depending upon usage, UASs can carry a variety of payloads and these create their own issues. While aerial surveyance/photography is not new in aviation, it brings tacit risk since, particularly for the rotary-wing UASs, the operator is likely to have equipment slung under the aircraft that could have a higher intrinsic value than the UAS. While it is unlikely that any such equipment will become detached during flight, a heavy or forced landing is likely to mean damage will occur first in the location of the payload.

FRAUD/THEFT

The main growth area in operations is in the sub-US$250,000 value category, where UASs are usually small, highly portable electronic devices frequently at the cutting edge of development. Since many airframes do not carry serial numbers, theft is a higher threat relative to larger manned aircraft and remains an ever-present possibility, particularly with interchangeable airframe parts and components, which are untracked, unlike those for manned aircraft.

ADVANCED TECHNOLOGY

Arguably, the wave that carries UASs forward is also its Achilles heel. UAS manufacturers are plentiful and — aside from the established manned aircraft manufacturers that have diversified — many may not, despite their financial backing, have the longevity to cope with the constant development required to sustain their market position. As a result, replacement parts for obsolete machines may become difficult to locate, further fueling the agreed value versus insured value debate, which could mean that a relatively low-damage UAS accident could turn out to be a total constructive loss in financial terms.

The glut of manufacturers also means there is a lot of minimally tested aircraft available, with little knowledge of the pitfalls of this type of UAS (one current focus involves the "mean time between failures," particularly for propulsion systems).

BROAD USES

Most rotary-wing UASs are manufactured as utilitarian lifting vehicles by design, with most capable of carrying out a variety of tasks using different payloads. Any one UAS can be put to a multitude of uses; theoretically, it could go from carrying out promotional photography one day to powerline inspection the next, for example, unlike one of its manned counterparts. Broad uses pose an issue for the underwriting community, as insufficient knowledge of the aircraft's risk profile and its many different uses may make it extremely difficult to accurately rate the risk against the exposure.

OPERATOR/PILOT EXPERIENCE

Compared to the stringent regulation covering manned flight, regulation surrounding the operation and licensing of UASs and UAS operators varies considerably. Military operators are likely to be trained "in-house" or by the manufacturer directly; while civilian operators are likely to require training by the manufacturer and may need to gain experience while operating the aircraft. In the UK, for example, one prominent insurer asks for confirmation of course completion before underwriting a risk; however, internationally, some countries do not have operator training courses available.

PRIVACY

What have not been addressed thus far, however, are concerns of claims against breach of privacy — which will no doubt be deserving of great attention in the near future. Privacy-related claims are currently excluded by all insurers; some haphazardly, others by the use of a definitive exclusion. A market exists for this type of cover, although without a precedent having been set, sum insured and terms and conditions are likely to be considered contentious by those who feel they require it. Rating may prove costly: Inherently, perhaps, privacy carries a moral hazard — the issue with privacy is that it would need to be established whether any invasion was "fortuitous" or not. By definition, the industry sets out to indemnify fortuitous acts, and investigating and adjusting losses could prove difficult.

CYBER

Currently, the majority of UAS usage is in the below-400ft banding, where the biggest risks exist. A lot of spectral issues exist around the 2.4mhz banding commonly used by these aircraft (particularly the lower-cost machines). The issue here is that many domestic broadband/Wi-Fi devices also use the same frequency and could, in theory, be used to hack into the flight path of an aircraft.

SPOTLIGHT

Cyber Risk

In January 2015, it was reported that India-based security engineer, Rahul Sasi, had developed a piece of malware that is able to trick the autonomous decision-making unit of a UAS into handing over control to a third party (hacker).

Billed as the "first backdoor for drones," once the malware (dubbed Maldrone) has infected the UAS, it makes it possible for a hacker to do anything from changing the destination of the UAS to making it drop out of the sky.

While other pieces of malware have been designed to specifically attack UASs in the past, Maldrone is unique because, for the first time, it targets the autonomous decision-making unit. And, unlike other pieces of malware that were specific to a particular make and model of UAS, Maldrone is designed to work with any type of software.

"Broad uses of UASs pose an issue for the underwriting community ... [making] it extremely difficult to accurately rate the risk against the exposure."

The ICAO's RPASP panel expects to complete the standards and recommended practices **in 2020.**

REGULATION*

The regulation of UASs differs — sometimes remarkably — from country to country. For UAS operations to be commercially viable, national and international aviation laws may need to be overhauled and/or a set of international regulations developed to take UAS use into account in a consistent way. The International Civil Aviation Authority (ICAO) is currently working on guidance for UAS operations (see below), but the process is expected to take some time.

EUROPEAN AVIATION SAFETY AGENCY (EASA)

EASA has a current policy (law) on UAS operations, which delivers guidance on operations for aircraft weighing more than 150 kilograms (kg). Aircraft under this weight are governed by each nation within the EASA umbrella, which put into place their own regulatory formats. While the initial law has been set, there is currently no detail on operator/pilot requirement or aircraft licensing, although EASA has recently released (March 2015) its *Concept of Operations* document, which presents a new regulatory approach for UAS operations. EASA hopes to address concerns of risk versus regulation by proportionately regulating risk against the use, operator, and environment. One of the key motivations alongside safe operation is to enable industry growth and, therefore, the class has been categorized into three spheres:

1. OPEN

Authorization from authorities is not required.

- Operations are anticipated to be VLOS under 500 meters (m).
- At an altitude not exceeding 150m above the ground or water.
- Outside specified areas (for example, airports, security facilities).

2. SPECIFIC

Requires a risk assessment to be approved by the National Aviation Authority (supported by authorized entities) and will lead to an operations authorization with specific limitations applied.

3. CERTIFIED

Higher associated risk, or for those UAS operations that are more aligned to manned operations or can be requested on a voluntary basis by organizations that provide remote piloting or sense-and-avoid. It is anticipated that the operator would receive a certificate of environmental certification, certificate of airworthiness, and certificate for noise. This categorization targets the higher end of commercial operations.

In addition to the above, the scope of the concept of operations also goes into detail on the following:

- Safety-promotion actions.
- Privacy/data risk protection (with the emphasis on national-level regulation).
- EU regulation EC785 (compulsory liability insurance).
- Key research areas.
- Further factors requiring consideration.

INTERNATIONAL CIVIL AVIATION AUTHORITY (ICAO)

The ICAO plans to deliver standards on the subject via its Remotely Piloted Aircraft System Panel (RPASP) in 2018. Once approved, these standards will set out guidelines for the members of ICAO to set their own requirements/ national regulations. This process will likely be a lengthy one, with some having suggested that the overall process could take more than a decade. Critically, the panel expects to complete the standards and recommended practices in 2020, with a clear goal for this timeline being the regulatory infrastructure behind air-traffic management and sense-and-avoid.

It is also expected that a manual for UAS operations will be published in 2018, ahead of the standards.

* Every effort has been made to ensure the accuracy of the regulatory information contained within this section at the time of publication; however, the global regulatory environment is a fluid one and this information continues to change on an almost daily basis.

Argentina

UAS usage is permitted but there is no direct regulation presently surrounding their use other than existing laws concerning manned aircraft.

Australia

UAS usage is allowed, and in order to fly one of any size for commercial benefit, two documents are required: a certificate for the operator and a certificate for the business. Additional ratings, including a radio operator's license, are required. Currently, the Australian Civil Aviation Safety Authority (CASA) allows UAS activities over unpopulated areas up to 400ft above ground level or higher with special approvals. The CASA will allow operations in controlled airspace with prior approval and coordination with Airservices Australia. Significantly, the CASA allows both visual meteorological conditions (VMC) and/or instrument meteorological conditions (IMC) operations with appropriate approvals.

Austria

Currently allows UAS usage up to 150kg for VLOS operations only.

There are strict laws about flying multi-rotor helicopters, which concern the categorization of their operating environment. If the UAS is to be operated around buildings or large conurbations, then a license is required. Operators must have been trained in Austrian Air law and be certified on the UAS type being flown and its system.

Belgium

Current operations are limited and need permission. Operators are required to have aviation experience, an operations manual, and a safe, remotely piloted aircraft.

Brazil

No current regulation.

Canada

Transport Canada has no current licensing requirements for UAS use, although the operator is required to have carried out a ground school class to operate the larger UASs and, if carrying out work for commercial purposes, carry a Special Flight Operations Certificate (SFOC). The regulator has offered an online advisory briefing, which lays out the responsibilities of operators and where compromise can be made against existing air law. Rules for "low-threat" UAS operations (under 25kg in weight and below 300ft) in rural areas away from airports were relaxed at the end of 2014 and a report has been carried out to make recommendations for the National Research Council.

SPOTLIGHT

Canada Considers ... Growth vs Governance

In August 2014, a report (updated in February 2015) prepared for the National Research Council of Canada made the following recommendations:

- The adoption of a broader set of UAS regulations in Canada remains a key factor for Canadian companies to continue to grow and be globally competitive in this emerging sector — all UAS stakeholders should promote and assist this development with Transport Canada.
- The first priority of research and development (R&D) should be solving the sense-and-avoid issue, based on clear regulatory policy of what these systems must accomplish, as this will be another key factor in fully exploiting UAS technology for commercial purposes.
- As the sector grows, further R&D support should be focused on the miniaturization of sensors and other UAS components, which will become a clear differentiator of competing systems and operations.
- Sensors and data-processing systems are the keys to effective use of UASs in most civil applications and in-depth understanding of these two topics should be incorporated into a Canadian UAS strategy.
- Development of collaborative, pilot projects will assist stakeholders to address the regulatory, market, and technology challenges that this sector faces.
- Investment by Canadian government agencies should focus on the items identified above.

Chile

Introduced UAS regulations on April 10, 2015, making it the first Latin American country to permit UAS operations. The new legislation covers private and public UAS usage and requires them to weigh less than 6kg and have parachutes. UAS are prohibited from flying at night or above 425ft, and must never fly more than 1,640ft from the operator. Operators are required to hold a license and register their aircraft with the Chilean Civil Aviation Authority.

Czech Republic

Currently allows UAS usage up to 150kg and for VLOS and beyond-visual-line-of-sight (BVLOS) operations. Both types of system are required to be certified, along with operators.

Colombia

Currently allows both VLOS and BVLOS operations.

Denmark

Currently allows UAS usage up to 150kg and for VLOS operations only. Restrictions are subcategorized by weight, operating distance from buildings and people, height (maximum of 100m), and distances to sensitive areas (airfields and military locations). Explicit instructions are offered in terms of spectrum (Denmark is one of the few countries to do so).

Estonia

Flying UASs in uncontrolled airspace is allowed below 500ft. The Estonian Civil Aviation Authority requires operators to hold a license when flying above 500ft or in controlled airspace. Operators are not distinguished by size of aircraft and damage carries a defined fine system, depending upon the object damaged.

France

Currently allows UAS usage up to 150kg and for VLOS and BVLOS operations.

Germany

Currently allows UAS usage up to 150kg and for VLOS operations only. There is currently some disparity between local laws; however, European-wide harmonization will likely provide a uniform solution.

Greece

In the process of preparing guidelines/regulation.

Hong Kong

Legally, UASs can be operated subject to a permission to fly or an application for permission to operate non-scheduled services for hire from the Hong Kong Civil Aviation department. The application must be supported by a pilot and crew qualification from a recognized training provider, operations manual and assessment, flight test reports, and a recommendation from the training organization.

Ireland

The Irish authorities currently regulate in a similar way to the UK Civil Aviation Authority. Permission for aerial work is required to operate UASs weighing 150kg or below. The application must be presented with a pilot/crew qualification from a recognized training provider, operations assessment, assurance of airworthiness for an aircraft with a message transmission optimization mechanism (MTOM) weighing above 20kg, flight test reports, and a recommendation from the training provider that the license should be granted.

Israel

Currently allows both VLOS and BVLOS operations.

Italy

Currently allows UAS usage up to 25kg for VLOS operations only.

Japan

Currently allows VLOS operations only.

Lithuania

Currently allows UAS usage up to 25kg for VLOS operations only. However, preparations are being made for a ruling on operations up to 150kg.

Malta

UAS usage is currently allowed and overseen by the Civil Aviation Directorate of Malta. Any company or individual wishing to carry out aerial work using UAS equipment is obliged to have a meeting with the Civil Aviation Directorate, which will then pass the details of the operator to a third-party contractor that will carry out the assessment of the pilot, aircraft, and intended operations. The contractor will then offer a recommendation to the Maltese governing body regarding the suitability of the application.

Netherlands

An exemption is required from some elements of Dutch airspace law for the legal operation of UASs commercially. The operator uses a third-party assessor to provide a recommendation to the Dutch Civil Aviation Authority (CAA). Currently, assessment criteria exist around the pilot (operator), the operations themselves, the airworthiness of the aircraft, and the reports from the flight tests carried out on behalf of the Dutch CAA.

Norway

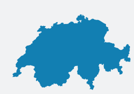
Preparations are being made for a ruling on operations up to 150kg.

Poland

Currently allows UAS usage up to 150kg and for VLOS and BVLOS operations.

Spain

The Spanish regulator, AESA, accepts applications for UAS operations, but it is currently taking a considered approach to its regulation, which is expected to evolve slowly. The regulator is currently developing guidelines for VLOS operations up to 25kg.



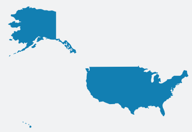
Switzerland

There are model aircraft rules currently in place, and UAS operations carried out in airspace above people require permits.

United Kingdom

Currently requires an operator to seek permission to operate for aerial work (commercial use). The requirement for this is mandatory on aircraft below 150kg, with machines that have a higher MTOM being governed by European rule (EASA). Operators, as in other European Union countries, are currently using third parties to carry out and assess potential operators on their behalf. Once again, key aspects around the application are the capability of the operator, the type and applicability of the operation, the airworthiness of the aircraft itself, and a flight test report.

The House of Lords has recommended that a register of UASs be created and maintained as a direct result of a committee established to look at requirements for safeguarding the use of unmanned aircraft. The committee expects that this will initially target commercial operations, perhaps expanding to include consumers eventually. The same report makes other recommendations, including the use of geo-fencing (allowing/not allowing) flight based upon GPS coordinates, clearer guidance for law enforcement, the application of a mark or designation for those systems that are considered safe to use, and guidance on what levels of insurance users should purchase.



United States

The Federal Aviation Authority (FAA) has proposed a framework of regulations that would allow routine use of certain small UASs to be integrated into public airspace by the end of 2015.

The draft regulatory framework has been published under a Notice of Proposed Rulemaking (NPRM), and suggested changes are aimed at addressing the operation of the aircraft and systems, the operators themselves, and the registration/markings that are carried in order to identify them. Critically, it is understood that a Certificate of Airworthiness, which is required from a manned-aircraft perspective, will not be required.

Presently, the FAA does not permit any unauthorized commercial use in connection with a business. It does, however, grant case-by-case authorization for certain UASs to perform commercial operations. To operate a UAS commercially, businesses must obtain either a:

- Section 333 Exemption AND a civil Certificate of Waiver or Authorization (COA); or
- A Special Airworthiness Certificate (SAC).

Small UASs may be operated for hobby and recreational purposes by following the FAA guidelines. UAS operations for recreational purposes follow similar guidelines as model aircraft and require the operator to fly vehicles no higher than 400ft and within line of sight.

United Arab Emirates (UAE)

UAE is set to issue regulations in mid-2015 regarding the use of UASs, banning their use from specified areas, including airports, public facilities, and properties.

The regulation has been brought about by the country's airspace regulator, the General Civil Aviation Authority (GCAA), and is understood to be based upon the weight of aircraft and type of operators, including commercial, corporate, and private users. The sale of recreational drones is prohibited on the basis of safety concerns.

Uzbekistan

Uzbekistan has banned the import, sale, and use of UASs (citing air safety and security concerns).

CONCLUSION

The inevitability of wide-scale UAS use should not be underestimated. As with any opportunities brought about by advances in technology, they go hand in hand with a set of new and little-understood risks, which UAS operators, regulators, and the insurance industry are all currently trying to understand and adapt to.

National and international regulation currently struggles to keep pace with advances in UAS technology; however, efforts are being made, albeit slowly. When looking at some of the predicted economic benefits of large-scale, commercial UAS operations, it appears only a matter of time before international regulators adopt a consistent approach to UAS use.

So far, the insurance sector has responded positively to this nascent industry, with some insurers being so proactive as to write their own safety rules to fill the gap left by regulators. The road ahead, however, is filled with challenges in terms of comprehension, education, and provision, both to end users and manufacturers.

Concerns over privacy also abound, and there is little doubt that this subject will generate much debate in future, particularly once a precedent has been set following a successful series of claims. At the same time, the industry is faced with a new client base that is itself grappling with a technology that is evolving at a rapid pace.

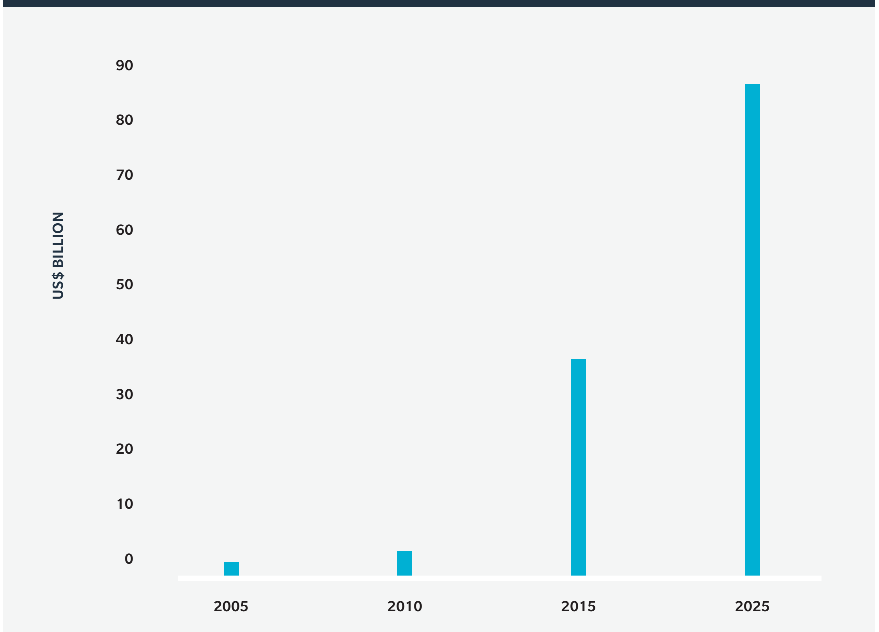
Presently, there are insufficient precedents set in terms of claims and education to enable underwriters to accurately assess the risks involved in UAS operations. However, with time, this data will eventually be generated (beyond the collation of data surrounding these machines and their performance reliability) the hard way, albeit at the smaller end of the scale.

Governance will bring structure and, better still, advances in technology (such as sense-and-avoid) will bring organization. If the two reach fruition together, then the growth that has been predicted could not only be delivered, it may prove to be far greater than anyone could have imagined.

APPENDIX I: GROWTH FACTORS

The history of unmanned flight goes back to the 19th century, although it was the defense industry that first foresaw and took advantage of the potential of UAS use, some 30 years ago.

In the past five years, international interest in UASs use has grown significantly. This growth is expected to continue, with spending on UASs set to pass US$100 billion by 2030[6].



While there has been wide-scale civilian use of unmanned rotary-wing aircraft in Japan since the mid-nineties (primarily for agricultural uses), the country is one of the few exceptions to the rule.

At the time of writing, the UK Civil Aviation Authority (CAA), for example, has issued 549 active licenses to carry out aerial work using unmanned aircraft — up from around 50 applications for the same work in 2010[7]. This is largely representative of the main growth area; low-cost UASs being used by operators who are diversifying (for example, photographers and film makers moving into aerial work, and security companies adding these aircraft to their capabilities).

6. *UAS Operators with a CAA Permission to Conduct Aerial Work (UAS)*, UK Civil Aviation Authority, available at: http://www.caa.co.uk/docs/1995/23Mar15%20RptUAVcurrentDates.pdf, accessed on April 1, 2015.

7. “Unmanned Aircraft Systems,” FAA.

SPOTLIGHT

Amazon tests UASs for deliveries

In December 2013, Jeff Bezos, chief executive of the world’s largest online retailer, Amazon, revealed the company was in the process of testing UASs to deliver goods to consumers.

“I know this looks like science fiction, but it’s not,” Bezos told CBS Television’s *60 Minutes* program. “We can do half-hour delivery ... and we can carry objects, we think, up to five pounds [2.3kg], which covers 86% of the items that we deliver.”

The company even posted a video on its website showing a UAS picking up a package from an Amazon depot and delivering it to a customer’s house.

The announcement and video came despite the fact that the US Federal Aviation Administration (FAA) has yet to approve the use of UASs for civilian or commercial use. “From a technology point of view, we’ll be ready to enter commercial operations as soon as the necessary regulations are in place,” said Bezos.

COST

Much of the increase in UAS use can be attributed to the reduction in cost:

PURCHASE PRICE

The development costs of UASs are not dissimilar to manned aircraft. Within the unmanned sector, software development for multi-rotor aircraft has been considerable, so much so that it is now available “off-the-shelf” to those manufacturers (particularly the small enterprises and universities) that may have a requirement for a bespoke airframe to fit their payload requirements. If anything, the low end of the class is significantly cheaper.

Operating costs in aviation are always significant. Safety is the number-one priority and the costs associated with this (which can include the requirement for multiple crew to be carried) are normally directly attributable to the size and complexity of the aircraft. To this end, many UASs are currently able to offer significant savings: One UAS operator we spoke to told us they could fulfill an offshore survey contract for one-tenth of the cost of a competitor using manned aircraft.

RUNNING COSTS

There is a quantum difference in the training requirements and the associated cost for UAS operators compared to manned aircraft pilots. Training a UAS operator to carry out aerial work could cost as little as approximately US$2,000, compared to a figure closer to US$150,000 for an airline or large commercial helicopter pilot.

TECHNOLOGY

While a reduction in the purchase price and running costs has contributed to the surge in mainstream UAS usage, further appeal has been generated by advances in technology, which have improved UAS capability and usability, dramatically increasing the potential application of these aircraft.

USABILITY

Most UASs are now so advanced in their inherent capability that the operator is required to provide very little input while the aircraft is airborne to successfully achieve a safe flight. 3D situational awareness in the form of GPS means that the flight path of the majority of UASs can now be controlled and pre-programed to a level that ensures accuracy to within a meter or less. Technology such as this allows a UAS to be guided to return to a pre-determined location, directed in-flight to a position defined by the operator, or taken over and flown manually, to achieve a bespoke flight-path; combined with advances in consumer electronics and mobile communications (specifically the use of gyroscopic sensors), this means that a safe flight profile can be maintained, even in the event of adverse weather conditions or propulsion systems failure, as stability will be largely uncompromised. The biggest challenge the operator is likely to face is not from the aircraft or its handling, but from the regulation in the country in question.

Not to be underestimated as a factor in the use of UASs is the accessibility of the user-interface. The ergonomics required to operate these aircraft are such that using them has become accessible to commercial operators and hobbyists alike. Some UASs, for example, can now be programmed and controlled by apps on a smartphone or tablet device.

MECHANICS

Propulsion systems are not exclusive to unmanned aircraft but the small scale of some unmanned aircraft means that electrical propulsion is often used via lightweight low-maintenance motors. This has implications for the power source, since battery technology has evolved, but equally it is required to evolve further in order for flight times to increase. Presently, only VLOS is considered for commercial operations, but as the parameters are pushed, then so will the ability to stay airborne longer.

APPENDIX II: MODERN TYPES OF UAS

As with manned aircraft, UASs are available as fixed-wing, rotary-wing, and lighter-than-air aircraft (airships).

FIXED-WING

OPERATIONS

- Require launching capabilities (be it ramp launch, conventional take off, or hand-held).
- Need larger areas to maneuver while airborne and to land in.
- Speed: 80–600 kilometers per hour (km/hr).
- Endurance: 45 minutes–30 hours.
- Load capacity: 2–2,000kg.
- Altitude capability: 60,000ft.

COMMON USES

Fixed-wing aircraft are inherently more efficient by design for flights not requiring vertical take-off and landing. There are other benefits too: While comparatively slow, gliders, with their high-aspect ratio wings, can "loiter" for hours, making them ideal for surveillance. Using the same design philosophies, the majority of military UASs are designed to be able to cover large distances, often at altitudes above commercial air traffic (in some cases up to 60,000ft.), and still remain efficiently on station far longer than their manned cousins. Commercial sector UASs offer similar design benefits, but the vast majority are presently at the opposite end of the scale, both in terms of size and cost. Common uses are user-defined mapping, laser (lidar) imaging, fire-fighting, and agriculture (mostly confined to VLOS operations).

ROTARY-WING

OPERATIONS

- Can take off vertically (removing the need for launch capabilities).
- Are very agile and can be flown through confined areas.
- Speed: Hovering/still–130 km/hr.
- Endurance: 15 minutes–20 hours.
- Load capacity: 2–3,000kg.
- Altitude capability: 16,000ft.

COMMON USES

Rotary-wing aircraft have a set of potential uses that are significantly more diverse than their fixed-wing cousins. While some uses by job-swap from manned to unmanned are obvious in rotary-wing operations (filming, for example), other uses are less than obvious ("drone-vertising" being just one example).

More so than fixed-wing UASs, rotary-wing UASs have harnessed the imagination of their operators due primarily to their speed of deployment and ability to take off and recover vertically. The smaller machines, being relatively cheap to purchase and operate, offer significant advantages to their users over their fixed-wing counterparts, and this is perhaps why the uses of these craft are so diverse.

LIGHTER-THAN-AIR

OPERATIONS

- Require "mooring" capabilities.
- Need larger areas to maneuver while airborne and to land in.
- Speed: Up to 115 knots.
- Endurance: Up to multiple weeks.
- Load capacity: Up to 250 tons.
- Altitude capability: Up to 70,000ft.

COMMON USES

New-generation airships offer significant benefits against their heavier-than-air cousins, including good lifting capacity, unrivalled endurance, and reduced costs (which are said to be a third of their fixed-wing counterparts). Uses include cargo, ultra-long surveillance operations, and advertising.

Notes

About this report

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