Taking Off

Drones Industry Outlook Through 2024

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KEY TAKEAWAYS

- *Drone investment opportunities lie within adding value through specialty components which add functionality or efficiency for drone hardware and software.*
- *The commercial and consumer drone segments will see exponential growth by molding military drone technology to produce creative niche solutions for enterprises and consumers.*
- *Air-taxi and drone delivery approval is hampered by regulation, while an investor may see greater returns in streamlining operations and automation in the short-term.*

BACKGROUND

Drones have been misunderstood since their initial deployments, primarily in military settings, focused on reconnaissance and surveillance. While depraved intentions produced this technology, Bill Gates has said that "drones overall will be more impactful than people recognize, in positive ways to help society."[1] Drones have numerous definitions, but BI intelligence defines them as "aerial vehicles that can fly autonomously or be piloted by a remote individual."[2] The hardware side of the industry has been dominated by one company, DJI, which has now amassed 72% of global market share - up from 50% in 2016.[3] Other companies such as 3D Robotics, Lily, Yuneec, and Parrot are all looking to chip away at the giant's market share.

With few dominant players, there have been only 10 drone companies who've managed to raise more than $10M within the unmanned aerial system (UAS) space - DJI, Airware, 3D Robotics, xAircraft, Skycatch, and Cyphy among others.[4] While all companies identified are not hardware-based, large incumbents mean that fewer companies will be pursuing full hardware solutions compared to years past. Because of this, early capital infusions have gone into investments that target end-to-end solutions, software and counter-drone technology.

Growth through the projection period is expected to occur across the three main segments of the industry - consumer drones, enterprise/commercial drones, and government drones. Many tech giants like Amazon and Google have been grabbing headlines with their initiatives, but start-ups are what drive the UAS space. More than 300 start-ups have entered the space since 2000 focusing on hardware, support services or operations.[5] Although less flashy than the headline grabbing giants, these players might achieve better returns for investors by focusing on a limited number of applications that solve critical problems, automate manual tasks and drive bottom-line impact.

The industries most likely to be disrupted by drone technology are security, construction, farming, disaster management and journalism. Over the last year, construction has been the fastest growing sector, surging 239%. Mining is second at 198%, farming at 172%, surveying at 171%, and real estate at 118%[6] Congruent to this growth is the expected increase in FAA drone registrations, which are expected to grow from 110,000 today to 600,000 by 2022.[6]

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[1] https://www.forbes.com/sites/richardlevick/2018/05/15/drone-industry-just-beginning-to-take-off/#295e118d72bc

[2] https://www.businessinsider.com/commercial-uav-market-analysis-2017-8

[3] https://dronedeploy-www.cdn.prismic.io/dronedeploy-www%2F39ba38d1-055a-40a4-a463-ef4dc42079f1_dd_2018_industry_predictions_f.pdf

[4] https://seekingalpha.com/article/4134123-lift-portfolio-new-heights-drone-tech

[5] https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/commercial-drones-are-here-the-future-of-unmanned-aerial-systems

[6] https://blog.dronedeploy.com/2018-commercial-drone-industry-trends-70b83e0a2e6f

MARKET SIZE

The global drone market is anticipated to reach $25B by the end of 2023, translating to an 18.2% CAGR over the projection period.[7] This number is comprised of all drone growth within the various sectors, mentioned above, including consumer, commercial and military drones with military applications making up the largest portion due to high price points. The consumer drone segment is expected to reach $3.3B by 2020.[8] The commercial drone segment is set to exceed $17B by 2024.[9] In 2016, there were about 105 deals completed, valued at a total of $541M.[9]

During the projection period, drone investment will begin to move into drones-as-a-service and specific hardware add-ons including sensors which will drive numerous use cases forward. The drone sensor market is expected to grow from $345M in 2018 to $1B in 2023 at a CAGR of 23.9%.[10] Among all sensor applications, the defense industry is expected to be the fastest growing segment of the drone sensor market. This is consistent with how drone technology has cascaded from military applications to commercial and consumer drones.

TYPES OF DRONES

Drones come in a multitude of different sizes, propulsion systems, and designated uses. They can be segmented into categories like rotary blades, nano drones, fixed wing and hybrids. Further, each of these drones can occupy the consumer, commercial or the government space.

The global drone market is seeing a shift of focus from the defense market to the commercial and consumer markets. As this space gains momentum, it is forming around the energy, construction, utility, agriculture, mining and film industries. This trend owes its emergence to the IoT (internet of things), where connectivity from sensors and sizing of electronics has created ever smaller and more powerful drones. This has been instrumental in helping to reduce limitations and develop a standardized framework for regulating airspace. It is expected in 2019 that revenue from the commercial segment should overtake the consumer segment.[4] Specifically, the US has seen strong growth in the commercial drone segment with activity rising from $40M in 2012 to $1B in 2017.[4] Consumer drone shipments are anticipated to reach 29 million in 2021 indicating a CAGR of 31.3%.[11] Commercial drones are anticipated to reach 805,000 shipments in 2021, a CAGR of 51%.[11] By 2026, it is estimated that both commercial and consumer applications will have an annual impact of $31-$46B on the United States GDP.[5]

The government drone market is by far the most mature. The US military has been using drones for surveillance and combat since 2001 and global military applications account for over 90 percent of the global drone market.[4] The US is the largest manufacturer and user of military tactical drones which is expected to continue through the projection period. Additionally, the US Department of Defense budgeted almost $7B on drone technology in 2018, representing a 21 percent jump over the previous year's budget.[12] The government drone market is dominated by large defense contractors such as Boeing, Lockheed Martin and Raytheon making early-stage investment opportunities uncommon.

Overall, there is a trend towards specialization within specific industries like agriculture, delivery systems, safety and security. This is creating niche solutions for unique problems like fixed-wing, vertical takeoff and landing (VTOL) and lighter-than-air drones. Today, fixed-wing usage has declined to just 3% as it has carved out markets within agriculture and oil and gas applications seeking longer range and more linear

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[7] https://www.researchnester.com/reports/drone-market-global-demand-growth-analysis-opportunity-outlook-2023/208

[8] https://www.goldmansachs.com/insights/technology-driving-innovation/drones/

[9] https://globenewswire.com/news-release/2018/02/28/1401040/0/en/Commercial-Drone-Market-to-hit-17bn-by-2024-Global-Market-Insights-Inc.html

[10] https://www.prnewswire.com/news-releases/drone-sensor-market-analysis-2018--global-forecast-to-2023-leading-players-are-trimble-bosch-sensortec-tdk-invensense-sparton-navex-raytheon-ams-and-systron-donner-inertial-300686298.html

[11] https://www.businessinsider.com/commercial-uav-market-analysis-2017-8

[12] http://dronecenter.bard.edu/report-drones-in-the-2018-defense-budget/

flight plans.[8] An investor could expect to see an increase in fixed-wing drones if federal beyond line-of-sight (BLOS) regulations are changed in the future. See the Barriers section for more information regarding BLOS.

DRONE MAKEUP

Drone systems vary based on their size, endurance, maximum altitude, range, battery life and loading capacity among others. However, all UAS's rely on several core components. An investor who understands these components will be better able to comprehend the design and production processes allowing for easier identification of opportunities across various stages of the value chain.

Prototyping of any new drone begins with the purpose that the drone will serve which will determine the components and parameters. The seven primary components of a drone include the payload, battery and flight time, propellers, motor design, frame design, onboard flight calibration system (FCS), range and radio, and the design of the controller/ground station. An investor will want to understand the landscape and value that companies are adding around the production of niche components. For example, different payloads will be applicable to different UAS's and will require different propellers, motors, and frame design creating investment opportunity for companies creating interesting solutions.

Each of these components provide ample opportunity for companies. For example, the current market segmentation for drones is rather loose meaning most drones are multi-purpose design. However, 3D printing will allow faster and more cost-effective frame design, significantly reducing time to market and providing more specialization for new products. A major component lending to how a drone will fly is the motor. Currently, the motor market is in its early stages and little innovation has taken place in this space. As this market matures, technology is most likely to focus on improving weight-to-thrust as well as thrust-to-power ratios. Additionally, as the current flowing through the electronics can increase power, it will also increase the loss of energy through heat. A company on the leading edge of electronic current innovation is poised to create more efficient and powerful motors used by the industry as a whole. Flight control systems are a byproduct of an already mature remote-controlled robot industry and no specific opportunities related to drones can be identified.[4]

As the size of components continues to decrease, multi-rotor propellers will enable the miniaturization of drones. However, as drone size declines, normal aerodynamics no longer apply in the same way. This requires more innovative propeller design ensuring stability and efficient transfer of power into thrust. As a result, it is expected that a new line of miniature propellers will take form as the nano-drone market evolves.[4] Battery life is the major driver when evaluating capacity and flight time that every drone depends on. Liquid-based batteries are heavy, inefficient and unsafe, thus dry batteries are used in the drone industry. The problem with dry batteries is that they do not generate as much power as liquid batteries. For the drone industry to reach its full potential, battery technology will require a breakthrough. Recently, Impossible Aerospace raised $9.4M leveraging battery and frame design technology to stuff its frame, end to end, with batteries, offering up to 120 minutes of flight time.[13] This innovation holds tremendous promise for exploratory rather than mission-based flights. For comparison, the DJI Phantom 3 has a flight time of about 25 minutes.[14]

Based on the current regulatory environment most low-cost consumer drones only offer line-of-sight control. As drones become more complex, feedback and greater radio and wireless coverage will be needed. Additionally, secure downlink channels will ensure data from sensors, cameras, etc. are sent to ground stations securely and with high-resolution. As of today, all consumer drone technology lacks in comparison to defense contractors, but it is expected that companies will begin investing in long-range wireless technologies.

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[13] https://techcrunch.com/2018/09/10/impossible-aerospace-raises-9-4m-to-sell-drones-stuffed-with-battery-cells/

[14] https://filmora.wondershare.com/drones/drones-with-longest-flight-time.html

Finally, all drones carry some sort of payload ranging from mount-on cameras, lighting accessories, DSLR camera or other surveillance modules. The availability of GPS has led to multiple add-ons to track specific flight paths and employ better remote navigation. Add-ons have just begun to witness their potential and will see tremendous growth as drone functionality becomes more categorical in the projection period.[4]

POTENTIAL FOR ACCELERATION

The drone industry has received much fanfare in the recent months and year due to the attention-grabbing headlines like drone delivery and flying taxis which evoke images of *The Jetsons*. While intriguing, the devil is in the both the details and regulatory externalities making widespread adoption unlikely within the projection period. However, companies may be unlocking the greatest potential from less head-turning applications like streamlining operations and automation in the short term. Digitizing operations will be most attractive to companies as they tend to make decisions based on economic drivers.

As more drones hit the skies, there will be more sensors and data to follow in the projection period. Currently, software companies are not yet playing an important role in data manipulation leaving gaps in the market for potential solutions.[15] Some of these solutions will take integrate drone data into everyday tools such as CAD, BIM, GIS and other software. Adam Kell of Comet Labs says that "drone sensors are becoming increasingly adept at collecting data, [and this is what has] VCs so enthused."[16] For industrial applications, there is increasingly powerful pieces of inspection software able to use pattern recognition for asset management. Further integrating AI and neural networks will allow these programs to automate inspection processes, creating more value.

As mentioned above, many drone hardware modules will become better and more efficient within the projection period, the most prominent being aerodynamics and battery technology.[4] Another area of growth is security; as more drones come on the market, counter UASs will become more common keeping sensitive areas safe by detecting and intercepting rogue drones. Collision and avoidance software will become a major driver of counter UAS.

Another innovative company, PVD+ out of Taiwan, is pioneering gesture control technology which is gaining traction as a whole. The software is meant to enhance the capabilities of a drone, specifically with regards to automation. Companies who offer innovative solutions, such as this, can expect to grab the attention of large incumbents and possible acquisition offers.

One of the major unknowns in the drone industry revolves around unmanned traffic management and is subsequently a hot button topic for almost every stakeholder, the Federal Aviation Administration (FAA), and NASA. The FAA is building an Unmanned Aircraft System Traffic Management (UTM) framework to govern drone operations as more drones come online and take to the skies.[17] The framework is being formed as not to straitjacket the industry during possibilities of rapid growth. However, each stakeholder has a different view of how it should ideally be formed with Google wanting an automated version of the current air traffic control (ATC) system that exists today. This system requires all flight operations to be scheduled prior to the flight and stored in a centralized control system. Amazon, on the other hand, is arguing for a collaborative sense-and-avoid system that prioritizes drones to see and avoid each other or any other airborne object. This inherently creates a less centralized command structure and would play into Amazon's drone delivery objective. The direction that the FAA pursues has immense implications for the future regulatory environment and therefore the direction of the drone industry, either enhancing or stifling progress currently being made by all entities.

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[15] https://www.droneii.com/wp-content/uploads/2018/04/Drone-Investment-Report-2018-sample.pdf

[16] https://pitchbook.com/news/articles/vcs-provide-the-fuel-as-drone-industry-takes-flight

[17] https://www.faa.gov/uas/research/utm/

BARRIERS

As the regulatory framework of the industry is still forming, the direction in which it will go is still up for debate. First, the most prominent issue is public acceptance. A 2016 poll showed that 44 percent of US respondents supported drone-delivery services.[4] Attitudes may soften as there is more ubiquity, but the industry has to build a lot of goodwill for the public to accept thousands of delivery and air-taxi drones overhead. Other barriers can be separated into technological, regulatory and infrastructure concerns.

Currently, there are many technological aspects of drones that must improve in order to deliver the ecosystem of drones that has been promised. This includes autonomous flights, battery performance, detect-and-avoid systems, air-traffic management, and location technologies. If these factors can improve, autonomous control, for example, will allow repeated and unpiloted surveillance of pipelines, mines and construction projects. Fully integrated UTM solutions are not expected to mature for more than a decade, making high-altitude flights impossible until that time.[4] The energy density of batteries is improving by 5-8% per year, but will continue to inhibit the potential of drones in the short term. In the long-term, a battery breakthrough will not only have great implications on the industry but will create a more sustainable energy economy. Drone-to-ground station communication will be another hurdle to overcome as current communication channels are vulnerable to malice.[15] As the importance of use cases grow, one can expect encryption to become stronger. Lastly, the largest obstacle might relate to design reliability standards and how quickly they can be more robust, creating industry confidence. Commercial aviation has a tolerance of one failure per one billion hours of flight, whereas 15% of new nano-drones sold today have bugs that will ground them within six months.[18]

Regulatory barriers are the greatest unknown within the drone industry with the major unreconciled regulation, UTM, mentioned in the previous section. In the same vein, there are still no rules regarding beyond-the-visual-line-of-sight (BVLOS). The FAA currently has waivers for BVLOS operations, however a widespread regulation remains vital to the commercial drone industry. The current market is limited because of a lack of adequate standardized frameworks in most countries, forcing companies to seek individual authorization across country borders.[4] Additionally, strict regulations are in place due to the growing threat of privacy and public security which is projected to inhibit the growth of the industry. Many countries could be looking towards how the US handles commercial applications, but the FAA has taken a very slow approach. The current apprehension of all regulatory authorities is their inability to "track, monitor, and manage the 'grey airspace' that drones occupy."[4]

As drones become larger and are able to integrate into more functions of daily life, more infrastructure will be needed such as vertiports, service centers, distribution hubs, charging and receiving stations. Currently, most UAS applications have modest infrastructure requirements; for example, most drones take off on a patch of grass or dirt and require the same power outlet as a smartphone. As sophistication increases, so will infrastructure requirements for charging stations, landing facilities, and other assets. Infrastructure funding decisions that are made today will have a major influence in the future. In locations where government does not have stake in UAS infrastructure, business could create private systems for exclusive use while charging other entities for service - creating a monopoly. Although public acceptance is uncertain this could give governments an incentive to create their own infrastructure or forge partnerships. Additionally, some entities have already begun constructing supporting infrastructure or acquiring air space as first-movers can claim prime locations.

OUTLOOK/IMPLICATIONS

Software, data analytics, and machine learning are driving numerous investments and directions within the drone industry. Looking at the industry in 2017, there was a clear shift towards software as many companies understood that it's not the drones, but rather the data they're gathering that is providing value for users.[14] This has led to multiple strategic partnerships allowing their niche creations to provide end-to-end solutions. As this market matures, value will continue to migrate towards software, most notably for

[18] https://www.forbes.com/sites/oliverwyman/2018/09/10/why-the-use-of-drones-still-faces-big-regulatory-hurdles/#e114bd81c0d9

turnkey solutions. Investors should be on the lookout for solutions that improve UAS operations by boosting detect-and-avoid systems, enabling analytics, and assisting with navigation in areas where drones cannot rely on GPS, like underground. Additionally, application program interfacing (API) is quickly becoming a requirement. Opening these channels and integrating them into established processes began in 2017 and is expected to become much more distinct in 2018 and beyond.[14]

The agriculture industry has become one of the major end-users in the commercial UAV market. Agriculture has a wide range of use cases such as planting, soil and field analysis, crop monitoring, health assessment, crop spraying and irrigation. One trend that will push agriculture forward is the collection and analysis of real-time insights.[3] As the technology comes to the forefront, it will not only assist agriculture, but construction, search and rescue and emergency services, among others.

Some companies are headed towards industry-specific solutions such as Veerum, which uses drones and 3D imaging to create 'digital twins' of projects, accurate down to the millimeter allowing construction companies, architects, and city-planners to validate their work against 3D models. As more enterprises, such as this, use drones there will be a greater need for automated flight and workflows. These workflows could be API related allowing drone data to connect with industry tools, allowing the mass use of data across an organization. Automation will be the key driver to both industry adoption and more valuable content. As automation becomes commonplace, data collection will require machine learning and AI solutions to be able to sort through mass amounts of data and provide better analysis.[3]

Amazon Prime with its drone-delivery service and initial UAS delivery services are expected to begin service within the next five to ten years.[4] Additionally, Google is developing a drone-delivery system structurally different from Amazon's, each with different views about how it should be run. This indicates the dependency on the supporting ecosystem of core hardware and software technologies as well as input from all stakeholders. More ambitious transport uses, such as air-taxis, will require much longer development and approval extending well beyond the projection period.[5]

Investors should understand that the drone industry could require more time to deliver value than typical investments. Therefore, when building a strategy around drones, longer time frames must be taken into consideration. Focusing on areas of the UAS value chain that have received relatively little investment such as infrastructure or drone-related services could prove more lucrative. Some of the most attractive opportunities may emerge in areas that address current business problems or areas just beginning to generate interest such as productivity solutions. While headline-worthy applications, like air-taxis, are entertaining to think about the length, volatility and capital-intensive structure of these companies should be off putting to potential investors.

As an investor gets more interested in the space, understanding the evolving ecosystem including manufacturers, vendors, resellers, value-added service providers and the regulatory environment will provide the knowledge needed to identify potential investments ready to take advantage of the exponentially growing drone industry.

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