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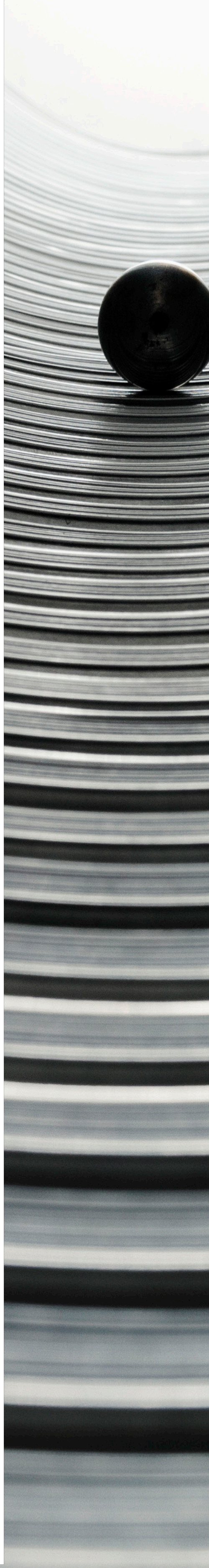

Counterpoint Global Insights

Drones

EDGE | DECEMBER 2021

WELCOME TO THE EDGE.
Morgan Stanley Investment Management's Counterpoint Global shares their proprietary views on a big idea that has the potential to trigger far-reaching consequences—ideas such as blockchain, autonomous vehicles, machine learning and gene editing.

Counterpoint Global's long-term ownership mindset emphasizes perspective, insight and thinking across categories, while our investment process focuses on identifying unique companies with sustainable competitive advantages. Through the EDGE, we share our framework for thinking about change and our process for recognizing patterns that may drastically alter the investment landscape over the longer term.

This work complements our team's more traditional, fundamental research to create a framework for long-term investing that is grounded in intellectual curiosity and flexibility, perspective, self-awareness and partnership.

Equipped with powerful sensors and next-generation perception software, drones now perform certain industrial tasks that previously required a human touch. We expect drone adoption to accelerate for last-mile delivery and data collection services as their autonomous capabilities advance and the need for expert drone pilots diminishes.

Drones have been around for almost a century. The first modern drones were remote-controlled wooden airplanes that the British Navy used for target practice in the 1930s. Throughout the 20th century, the defense industry provided the main funding for drone research and applications were confined to the battlefield. Private investment in drones did not pick up until the early 2000s, when falling costs for electronic components and increased energy density in lithium batteries made consumer drones economically viable. Unlike their military counterparts, consumer drones are designed to be small, inexpensive, and nimble. Enterprise drones have evolved from this vein of innovation. Today, enterprise drones show promise in a variety of commercial applications across many industries.

How It Works

A drone, or unmanned aerial vehicle (UAV), is any aircraft that operates without a human pilot onboard the aircraft. Drones are operated either autonomously by software or remotely by a human operator at a base station. When operating autonomously, drones use a variety of input sensors—such as inertial measurement devices, GPS, and video cameras—combined with sophisticated perception and navigation software to plan and execute an optimal flight path with high precision. When operating remotely, the sensor data is transmitted wirelessly to a human operator who controls the drone in real-time via a remote connection. In some applications, drones switch between autonomous and remote-controlled modes of operation.

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Drones are often classified into three broad categories based on how the aircraft generates lift. Fixed-wing drones generate lift by inducing airflow over a fixed wing attached to the aircraft body, like a traditional airplane. Consequently, fixed-wing drones require forward movement to fly and an aerodynamic body shape is a key design consideration for reducing drag at high speeds.

Multi-rotor drones use upward-facing propellors to generate lift. This means that they can take off and land vertically, quickly reverse direction, operate at low speeds, and even hover in place. However, this increased agility comes at the price of lower energy efficiency and range. While fixed-wing drones can generate lift passively after reaching takeoff speed and can glide to conserve energy, multi-rotor drones must constantly spin their propellors in order to stay airborne.

Hybrid vertical-takeoff-and-landing (VTOL) drones offer the best approach for applications that require both long operational range and high agility. These drones use a fixed wing and forward-facing propellors for forward flight, and upward-facing propellors for takeoff, landing, and hovering. Hybrid VTOL drones are generally more expensive and difficult to operate than fixed-wing and multi-rotor drones because of their complex design.

Why enterprise drones are disruptive

Enterprise drones are a disruptive technology because they combine several key innovations. First, they are *small*. They can be much smaller than manned aircraft since they do not carry a human pilot. Camera drones can easily fit inside an engineer's suitcase or a soldier's backpack, and package delivery drones take up about as much storage space as a lawn chair. Their small footprint helps them to navigate through dense cityscapes and cramped industrial warehouses.

Second, many drones can *hover*. Hovering enhances maneuverability and enables a vertical takeoff and landing. This eliminates the need for long runways, which are inconvenient, or costly launch equipment.

Third, they operate *autonomously*. This allows drones to take on complex operations that used to be reserved for expert technicians. For instance, today's most advanced enterprise drones can perform bridge inspections with no human intervention. An inspection drone can autonomously scan an entire bridge—even flying between trusses in order to spot beam deformation and rust in hard-to-reach areas—and create an accurate 3D image that an engineer can analyze safely from a distance. This operation would be impossible without the combination of a small footprint, the ability to hover, and the capability to operate autonomously.

Applications that require these features will benefit the most from enterprise drones. Package delivery is a good example. The last mile accounts for 53 percent of shipping costs, and courier and local delivery services in the U.S. collect over $100 billion in revenues every year.[1] According to Morgan Stanley Research, the online food delivery market alone is expected to reach $60 billion in sales by 2025.[2] Yet, profitability for last-mile delivery remains low due to high and rising labor costs.

Drone delivery promises to reduce those costs significantly by requiring only a small, centralized team to operate and maintain a large fleet of autonomous drones. Hybrid VTOL drones loaded with small packages can takeoff vertically from parking lots or building roofs at retail locations and can drop off packages by lowering them via winch while hovering at the delivery site. At scale, these drones can decrease delivery costs for high-priority small packages and online food orders from the current levels of $5 and $10 per delivery to $1 or less. If passed on to the price-sensitive consumer, these savings can accelerate e-commerce adoption and make online food delivery a realistic option for more people.

Drones are not the only game in town when it comes to autonomous delivery. Significant investment has gone into the development of driverless cars over the last decade, and several startups are designing compact autonomous vehicles (AVs) specifically for last-mile delivery. A comparison between drones and AVs shows that each method has unique strengths and therefore the solutions may be complementary.

On the one hand, drones are smaller and lighter than AVs and are built mostly from consumer-grade components. This translates into a lower cost per vehicle. Drone delivery can also be very fast. Hybrid VTOL delivery drones can fly efficiently at speeds well over 45 miles per hour. In addition, drones can also take the shortest route to the delivery site because they are not confined to road networks and ground traffic.

On the other hand, drones have a more limited operating scope than AVs. No fly-zones, such as those around airports and hospitals, and adverse weather conditions may preclude certain deliveries. Too much weight can also compromise a drone's agility and low-profile. As a result, cargo is limited to less than ten pounds, which is much less than even small AVs can handle. While these tradeoffs will likely result in separate, defensible niche markets for drone and AV delivery, direct competition is almost certain in some scenarios.

Beyond delivery, there is a growing demand to use drones to collect data in industries and jobs that require surveying, tracking, monitoring, imaging, and filming. Drones are good for these applications because they provide a flexible, unobtrusive, and low-cost aerial platform upon which operators can mount a variety of sensors. For example, the insurance industry now uses imaging drones to provide high-quality property inspections, reducing the time it takes to issue repair estimates after a loss.[3] The agriculture industry deploys drones fitted with multispectral sensors to help farmers apply fertilizer more accurately, spot variabilities in crop health, and map difficult terrain. This is a $30 billion industry according to some estimates.[4]

In a classic case of disruptive innovation, low-cost drones are replacing manned helicopters traditionally used for filming dramatic movie scenes, monitoring traffic jams, and tracking suspects on the move. We expect data collection by drones to expand as data becomes easier to store and analyze at scale, and as companies across industry recognize the value that data can bring to their businesses.

Challenges

Regulatory risk is perhaps the biggest threat to the enterprise drone industry. The Federal Aviation Administration (FAA) regulates civil aviation in the U.S., and although rules are well established for manned aircraft, an appropriate framework for unmanned aircraft is still being worked out. As such, the approval process for commercial drone operations today involves a patchwork of temporary waivers and exceptions to rules intended for manned aircraft. Any operations that are approved are heavily constrained. For example, with only a few exceptions, outdoor commercial drone operations today must place a human observer within visual line-of-sight to the drone throughout the entire flight. This effectively prohibits fully autonomous operations.

The only existing path toward exemption of this rule involves a tedious, multi-year certification process that has been successfully completed by only three package delivery drone operators thus far. Even these privileged companies have restricted operating boundaries and

[1] https://www.inboundlogistics.com/cms/article/uncorking-last-mile-bottlenecks/

[2] https://www.morganstanley.com/ideas/food-delivery-app-profits

[3] https://www2.deloitte.com/us/en/pages/financial-services/articles/infocus-drone-use-by-insurance-industry-flying-higher-farther.html

[4] https://www.precisionag.com/in-field-technologies/drones-uavs/the-role-of-drone-technology-in-sustainable-agriculture/

must be explicitly granted authorization for each type of operation they want to conduct. Until a better approval process is developed for beyond-visual-line-of-sight drone operations, many commercial applications—especially those involving autonomous capabilities—will remain out of reach and industry growth will suffer.

However, there has been a steady pace of regulatory progress over the past few years. In 2017, the FAA set up a joint drone development program between state-level Departments of Transportation and industry startups. This program allowed regulators and industry participants to hear from each other and begin working toward full integration of drones into the National Airspace System which governs manned aircraft flights.

In the spring of 2021, the FAA released standards for Remote ID, an identification system for drones similar to license plates for cars. Remote ID will bring traceability and operator accountability to the drone industry, a key milestone towards allowing advanced autonomous operations. In June 2021, following the rollout of Remote ID, the FAA set up a rulemaking committee to develop performance-based requirements for beyond-visual-line-of-sight operations. Recommendations from the committee are scheduled to be delivered back to the FAA by the end of 2021. If stable progress continues, fully autonomous commercial drone operations at scale may be a few years away.

Apart from regulatory risk, there is a smaller concern that society may not accept drones flying over communal and residential areas. Similar to the community pushback on satellite constellations causing visual pollution in the night sky, people may react negatively towards seeing and hearing drones zipping over their houses. Privacy concerns about video recording over private property may also cause backlash. If drone operators do not take these concerns seriously, constituents may pressure their local governments to add no-fly zones and other restrictions for drones operating in certain residential areas.

Establishing trust and an open dialogue with local communities may help mitigate this societal risk. For instance, one drone delivery company decided to redesign its motors and propellors to reduce noise after receiving complaints from unhappy community members. This collaborative response helped repair the company's relationship with the local community, and it still operates there today.

Conclusion

The future for enterprise drones looks bright. Delivery drones may become a significant part of the last-mile delivery network, expanding the flow of goods from the relatively few, large distribution centers to the millions of small, individual homes that depend on those goods. Data collection drones may provide a unique vantage point as industries continue their digital transformation and data-driven approaches become essential to modern business operations. However, enterprise drones will only realize their full potential when autonomous operations become commonplace. In this future, at least some level of automation and job displacement should be expected. As with other autonomous technologies, the effect of this automation on industry and society may ultimately be what matters most.

OTHER DISRUPTORS

Other themes the team is currently researching include

- Quantum Computing
- CAR-T Therapy
- Automation/robotics
- Blockchain
- Autonomous vehicles

Risk Considerations

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Counterpoint Global

New York

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SAM CHAINANI	Head of Counterpoint Global~ New York, Technology	27	27	23
JASON YEUNG	Health Care	26	21	19
ARMISTEAD NASH	Business Services, Software	23	21	19
DAVID COHEN	Consumer	35	30	24
ALEX NORTON	Consumer, Industrials, Technology (ex Software)	28	23	23
MANAS GAUTAM	Head of Global Endurance, Generalist	11	8	8
ANNE EDELSTEIN	Health Care	12	5	5
ABHIK KUMAR	Software, Media	14	4	4
JENNY LEEDS	Healthcare	7	4	4
JOSHUA JARRETT	Director of Research, Generalist	18	3	3
RUOBING CHANG	Internet	11	7	3
ALEKS SAMETS	Payments	3	3	3
BETH FIFER	Health Care	11	2	2
MUHAMMADRAZA PANJU	Internet	4	2	2
PETE STOVELL	Generalist	29	2	2
MICHAEL MORITZ	Generalist	5	1	1
CONSILIENT RESEARCH				
MICHAEL MAUBOUSSIN	Head of Consilient Research	36	3	3
DAN CALLAHAN	Consilient Research	18	3	3
DISRUPTIVE CHANGE RESEARCH				
STAN DELANEY	Big Ideas, Emerging Themes	22	22	19
SASHA COHEN	Big Ideas, Emerging Themes	6	6	6
JUSTIN AMEZQUITA	Big Ideas, Emerging Themes	3	3	3
VASILEIOS PRASSAS	Big Ideas, Emerging Themes	9	2	2
SUSTAINABILITY RESEARCH				
THOMAS KAMEI	Head of Sustainability Research, Internet	11	11	11
DERRICK MAYO	Sustainability Research	18	9	2
CLIENT RELATIONSHIP & BUSINESS MANAGEMENT				
MARK TODTFELD	Chief Operating Officer	28	18	4
KERRY ANN JAMES	Head of Client Relations, Portfolio Specialist	26	6	2
PRAJAKTA NADKARNI	Portfolio Specialist	19	16	12
MICK MORAN	Portfolio Specialist	9	9	1
MCKENZIE BURKHARDT	Portfolio Specialist	20	20	20
XAVIER SALAZAR	Portfolio Analyst	5	5	1
KATHRYNE DOWNS	Portfolio Specialist ~ Global Endurance	11	11	1
EARL PRYCE	Portfolio Administrator	23	23	16
CHAYSE MORGAN	Portfolio Administrator	3	3	3
ERICA CASARENO	Portfolio Administrator	1	1	1
AMBER YANG	Business Management	13	5	2

Asia

Global, International, Asia

KRISTIAN HEUGH	Lead Investor, Head of Global Opportunity

- 13 Investors
- 6 Portfolio Specialists
- 1 Portfolio Operations Analyst

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CRC 5361138 Exp. 12/31/2023 10336861_CH_0823 Lit-Link: CNTRPTEDGE-1221