



Appendix E. Uncrewed Aircraft Systems (UAS) Case Studies

Uncrewed Aircraft Systems (UAS, or drones) are a rapidly growing segment of the aviation industry. UAS are defined as a powered aircraft and all of the associated support equipment, control station, data links, telemetry, communications, and navigation equipment necessary to operate it.²³ UAS are operated remotely with no pilot on board. According to the FAA, there are nearly 900,000 drones registered in the U.S., including over 300,000 drones used for commercial purposes. Nationally, there are over 250,000 remote pilots certified, with approximately 7,000 (or 3% of the total) in Pennsylvania.²⁴ Despite the prominence of registered drones and certified pilots, the emergence of UAS in the aviation industry is still new and development, application, and capabilities are still evolving.

The economic impact of UAS across all related industries within the Commonwealth has not yet been assessed and is not included in the scope of the 2022 PA AEIS. However, in order to assess the prominence of UAS in Pennsylvania's largest industries and to understand the impact of UAS in the Commonwealth, a qualitative assessment of UAS across multiple industries was undertaken. This qualitative assessment is meant to better understand the reach of UAS across traditional industries, as well as how UAS have spawned new industries focused solely on this technology. To gather this information, outreach to businesses across more than 20 industries was conducted via nearly 30 interviews with key staff in partnership with the Pennsylvania Drone Association. The case studies included in this appendix were developed based on this outreach.

²³ "What is UAS?" Center for Unmanned Aircraft Systems in Public Safety. <https://www.uaspublicsafety.org/what-is-uas/>.

²⁴ "UAS by the Numbers." Federal Aviation Administration. https://www.faa.gov/uas/resources/by_the_numbers/.

UAS AND AGRICULTURE

CASE STUDY

Agriculture is a prominent industry within Pennsylvania.¹ With over 53,000 farms that cover over 7,200,000 acres of land, farmers are embracing Uncrewed Aircraft Systems (UAS, or drone) technology to improve their business through bettering their farming method. This case study documents one Pennsylvania business, Swift Aeroseed, that is using UAS to aid farming operations across the Commonwealth.

UAS Enable Ingenuity in Agriculture

Currently operating under a Ben Franklin Research and Development Grant, Swift Aeroseed is a Pennsylvania-based agricultural drone service company that specializes in cover crops and ecological services. Cover crops are a conservation practice; a living crop is layered over soil to enhance health and fertilization of soil, improve water quality, and reduce harmful weeds.

Swift Aeroseed's drones are designed to carry over 100 pounds of seed and to seed 30 acres of cover crops an hour.² According to the US Census of Agriculture, the average Pennsylvania farm is 137 acres in size. Therefore, these drones can cover an average farm in just under five hours. After an expected Federal Aviation Administration (FAA) approval, Swift Aeroseed will test their drone design using five southern Pennsylvania farms from York, Adams, Lancaster, Perry, and Cumberland counties. According to a Swift Aeroseed representative, the ecological benefit of drone usage and cover crops includes reduced nitrogen, phosphorus, and sediment in local water and streams, along with carbon sequestration. Investments in this company, like the Ben Franklin grant, promote ingenuity in finding ecological and cost-based agricultural solutions.

Using UAS Results in Cost Savings for Pennsylvania's Farmers

Although cover crops are beneficial, they do have some disadvantages. Chief among these are costs, which is a main reason why farmers have previously strayed away from using cover crops. Methods to lay cover crops have historically been expensive or inefficient and rely on the use of drill tractors and airplanes. The tractor method has several disadvantages. Tractors and ground seeders cannot operate in wet conditions. Therefore, farmers utilizing this method must be very specific about when to seed to avoid wet conditions. Additionally, many common tractors do not have the ability to seed within a current crop (this method is referred to as "over-seeding"). As a result, cash crops must be harvested before the cover crop is placed. By waiting for harvest, a farmer's late-cover crop may not effectively protect the soil. Other methods include using airplanes or inter-seeder planters, which are both expensive.

¹ <https://www.nass.usda.gov/AgCensus/>

² <https://cnp.benfranklin.org/finalists-in-ben-franklins-50000-big-idea-contest-announced/>

Using drones for cover crops has several advantages. Drones can seed at any time of the year over a standing crop, do not disrupt the harvesting of cash crops, and can be operated even if the ground conditions are wet. Ultimately, drone usage is cheaper and more effective than previous forms of technology and can save the average farmer top-soil costs. According to a Swift Aeroseed representative, "By not choosing cover crops, farmers lose \$45 to \$60 an acre in topsoil; this loss in topsoil only adds to fertilization costs."

Swift Aeroseed works to educate farm owners on Pennsylvania's multitude of cost-share programs. Cover crops are considered a conservation practice, and with the help of these cost-share programs, ensure low out-of-pocket costs for Swift Aeroseed's services. According to their spokesperson, Swift Aeroseed's goal is to connect these farmers so that the benefit of UAS technology is fully accessible to any agricultural business.

Conclusion

The previous costs and methodology of laying cover crops resulted in loss of revenue and income for Pennsylvania's farmers. UAS technology and Swift Aeroseed work to mitigate poor soil quality and loss of soil through easily accessible and inexpensive cover cropping techniques. After full FAA approval, Swift Aeroseed's drones and innovation will usher in a new, more beneficial farming technique. This ingenuity supports a booming future for both drone technology and agriculture applications.

UAS AND COMPONENT MANUFACTURING CASE STUDY

Component manufacturing services produce a desired piece of a greater whole in the Uncrewed Aircraft System (UAS, or drone) industry. For example, components of drones include propellers, motors, and cameras. These components can boost performance, reduce costs, and enable new vehicle construction. This case study highlights one Pennsylvania-based company providing this service, IQ Motion Control.

Advanced Motor Technology is Produced in Pennsylvania

IQ Motion Control is a Philadelphia-based company that provides premium motors and controllers to commercial and defense drone companies. As vehicles are getting more sophisticated, they're demanding higher-end motor control and performance. IQ Motion Control fills this need by providing ultra-efficient, responsive, and robust motors and controllers for aerial propulsion systems. Their hardware consists of an integrated motor and control with an embedded position sensor. The position sensor allows the motor controller to know exactly where the motor is in its rotation, and with that information, IQ's software can optimize the motor's performance. This technology is typically found on high-end, expensive industrial machinery, whereas drones usually use sensorless solutions. IQ Motion Control is selling its product to drone companies that specialize in aerial data collection, surveillance, and delivery.

One of IQ Motion Control's biggest customers, Flyability, is located in Switzerland and has achieved great benefit through superior motor control. Flyability is in the business of indoor inspection of high-value assets. It is difficult for drones to fly inside as any collision can permanently damage a vehicle. Flyability, however, has created a drone with a carbon-fiber cage to protect the vehicle when it inevitably collides with an obstacle. Flyability utilizes IQ Motion Control's motors because they have the ability to reverse instantly. This feature allows Flyability's drone to recover effortlessly from collisions and in certain cases, prevents the vehicle from crashing to the ground.

Growth is in the Future for Pennsylvania's Component Manufacturing Companies

So far, IQ Motion Control has raised \$1.3 million in funding; \$1 million of this investment has been derived from Pennsylvania companies and individuals. According to a spokesperson, "All motor designs and software development are stemmed out of Philadelphia." IQ Motion Control has 10 primarily Pennsylvania-based employees and are continuing to push their products forward through research and development. Next year they expect their employment to double, and by 2024, the company expects to expand to thirty employees. IQ's goal is to open a manufacturing facility as the demand for their motors increases. The total motor output for IQ Motion Control is currently 5,000; by this time next year, that number is expected to reach 10,000.

Conclusion

As demand for specialized, high-quality drone equipment increases alongside a general increase in UAS use, drone component manufacturers will be critical to fill the need. These businesses are expected to see sustained growth as UAS technology and innovation continue to advance rapidly. Customers like Flyability will continue to benefit from advanced component manufacturing which will enhance their own continued operation.

UAS AND CONSERVATION

CASE STUDY

Uncrewed Aircraft Systems (UAS, or drone) technologies have adapted to tackle important issues such as methane detection, surveying wildlife to support anti-poaching and anti-wildlife trafficking efforts, and enforcing reductions in human interference in the natural world. UAS technology has been integrated into the conservation world to survey wildlife and land, as well as monitor areas of conservation. This case study examines how one Pennsylvania-based company, Remote Intelligence, is using its drone technologies in conservation efforts.

Conservation Has Found a Home in Pennsylvania

Remote Intelligence is a Pennsylvania-based company that provides intelligence consultation and solutions, focused on UAS. Such services include 3-D mapping, aerial inspection services, video inspection services, aerial surveying, emergency support services, system designing, training, and sales. Remote Intelligence began in 2013 and has so far invested over a million dollars in the UAS industry and by hiring Pennsylvania-based pilots, with more investment to come. At one time, there is anywhere between eight and 15 Pennsylvania-based pilots employed at the firm.

Although Remote Intelligence is stationed in Pennsylvania, its operations are national and international. For instance, a recent contract had them flying drones over the Pentagon in Arlington, Virginia for a deer density study. Remote Intelligence's clients include Shell, RE/MAX, the Alaska Department of Fish and Game, Dominion Energy, and RTI International.

Remote Intelligence technology specializes in fully integrated, geo-rectified, 3D-modeled mapping for applications in the energy and environmental industries. The company also focuses on wildlife conservation through its nighttime thermal surveys for animal counts. Other conservation efforts for Remote Intelligence include water leak detection, LiDAR surveying, and wind turbine inspection. As a spokesperson for Remote Intelligence stated, "Drone technology is another tool in the toolbox of ensuring conservation."

Drones Provide Safer, Faster Data for Conservation

The founders of Remote Intelligence discovered the applications and benefits of drone technology through their separate wildlife consulting company, Wildlife Specialists. Two of the greatest benefits the founders found in using UAS for conservation efforts are safety and efficiency of application. Before drones, surveying wildlife required “boots on the ground.” Teams would physically walk over immensely large areas of land to survey. Not only does this method take considerable time and effort, but it can also be dangerous. Many of the regions surveyed are remote, have hazardous terrain, and present wildlife threats such as snake and tick bites. Remote Intelligence technology allows less human exposure to the dangerous points of conservation. Human interaction with the land then becomes targeted and safer due to drone technology.

Remote Intelligence collects data that is precise, faster, and safer. These data can also be historically used to back up projects in the oil and gas industry. Recently, Remote Intelligence surveyed and mapped a 200-mile-long Pennsylvania pipeline in just 60 hours of flight time. Instead of having one investigator take photos, teams can analyze the geo-referenced, high-quality imaging for any potential problems or hazards.

Conclusion

UAS involvement in conservation efforts demonstrates the far-reaching benefits of drone technology. With a Pennsylvania-based company at the forefront of this industry, UAS technological advancements have supported environmental improvements. Remote Intelligence offers a wide variety of mitigation efforts and expects further growth within the Commonwealth and from its new Alaska-based office.

UAS AND CONSTRUCTION

CASE STUDY

Uncrewed Aircraft Systems (UAS, or drones) are being used throughout Pennsylvania to increase efficiency, safety, and success in a multitude of industries. This opportunity has not been overlooked in the construction industry. High-speed aerial imaging precision, scanning capabilities, and infrared, geo-locating, and thermal sensors provide immeasurable opportunities and the promise of increased profits for the construction industry. Not only can drones monitor worker activity and safety areas, but they are also serving as a basis for pre- and post-operation analysis. Drone technology is laying the foundation for the future of construction practices. This case study highlights two Pennsylvania-based construction businesses using UAS, Precise Visual Technologies and Mowery Construction.

Drone Technology is Revolutionizing the Construction Industry

Precise Visual Technologies is a traditional engineering firm that has been in business since 1989. This company specializes in AEC (Architecture, Engineering, and Construction) and conducts business in the public, governmental, and private sectors. Operating out of Northeast Pennsylvania, Lehigh Valley, and Pittsburgh, Precise Visual Technologies adapted drone technology in 2016 and has since invested over \$100,000 in equipment, pilots, and training. The drones flown capture large amounts of data primarily for construction monitoring. These drones fly over construction sites to monitor changes, ensure structural stability, and update aerial imaging in remote areas. Precise Visual Technologies has eight Pennsylvania-based Federal Aviation Administration (FAA) Part 107 pilots. Recently, a team of pilots flew drones over a shopping center construction site. In 45 minutes, an aerial map of the entire site was completed. Without drone technology, this task would have taken three to four days. According to a Precise Visual Technologies spokesperson, "With a drone, you have everything. You have the whole construction site captured town to a tenth or half of a tenth of a foot in under an hour. You can continuously pull from this data as the construction proceeds."

Mowery Construction is a Pennsylvania-based general contractor that has been around for nearly 100 years. Specializing in building construction, Mowery finishes anywhere from 20 to 30 projects a year and has an annual revenue stream of \$200 million. About three years ago, Mowery implemented drone technology as simply a way to track progress on projects. However, drones quickly expanded from just aerial imaging to recording, preplanning, assisting in 3-D planning of building projects, thermal imaging, and topography. The sub-contractors of Mowery even use drones to keep track of digging and removal of dirt. According to a Mowery representative, now one out of every eight employees at Mowery Construction has their drone pilot license. Many of these pilots have undergone flight school to increase their skill and accuracy. Before drone technology was implemented, Mowery had aerial pictures (through airplanes) for one out of every 10 projects. Now, more than 90 percent of projects utilize aerial imaging. According to a Mowery spokesperson, "We're a leader in construction in this region, I think, because of our use of drone technology."

UAS is Promoting Booming Construction Businesses

For Precise Visual Technologies, the two main benefits of adding drone technology are safety and client expansion. Before UAS, Precise Visual Technologies would send surveyors out to construction sites. Surveyors were often working in high-risk areas, such as along roadsides. Now, drone data collection is accessible from the office rather than in the field. Also, according to a spokesperson, drones have provoked new, diverse clients: “90 percent of the jobs we do with drone technology we wouldn’t have been able to do before. It has been a large driver of our revenue stream and the capability of the jobs we can do [...] the different types of clients coming to us is the greatest benefit.” Overall, Precise Visual Technologies has equated success and higher revenues to their utilization of drone technology.

According to Mowery Construction, their previous method of imaging could only be done with airplanes. These planes would fly over construction sites for \$1,000 a flight. Planes allow for some aerial imaging but were incapable of providing valuable information such as imaging of subsurface conditions, analysis of the orientation of the building, and utility and foundation imaging. Drones allow for little to no hazard, more accurate imaging, and cost approximately \$1,000 for the drone equipment. These drones are expected to last 12 years. A Mowery representative emphasized that the drone paid for itself after one job. Not only this, but client satisfaction has increased due to drone technology. As a Mowery representative stated, “Client demand and satisfaction, along with cost savings, has increased profit and our revenue.”

Conclusion

Both construction companies existed before the emergence of drone technologies and both have reported rapid increases in revenue, jobs, and clients due to their adoption of UAS. For Precise Visual Technologies, their clientele has expanded beyond the scope of their original services. For Mowery, client satisfaction, overall cost, and profit are directly tied to their UAS usage. Both companies also reported that UAS have simplified their method of collecting data; though the methodology is simple, this data is immensely more accurate and versatile. Pre-construction, construction, and post-construction are constantly being analyzed, leaving little room for error. These successful businesses are expected to continuously find new, cost-saving, efficient, and safe uses for drone technology.

UAS AND DEPARTMENT OF DEFENSE CASE STUDY

According to the Department of Defense, “The primary purpose of the Department of Defense (DOD) domestic aviation operations is to support Homeland Defense (HD) and Defense Support of Civilian Authorities (DSCA) operations, and military training and exercises.”¹ The DOD utilizes Uncrewed Aircraft Systems (UAS, or drone) technology to train and carry out potential international missions. This case study highlights one Pennsylvania-based business supporting DOD operations, Navmar Applied Sciences Corporation.

A Pennsylvania-Based Company Supports the DOD

Navmar Applied Sciences Corporation (NASC), founded in 1977, is a Service-Disabled Veteran Owned Small Business (SDVOSB), currently employing 206 employees. They are headquartered in Warminster, Pennsylvania and manufacture aircraft in Johnstown, Pennsylvania. Additionally, they have locations in six other states. NASC has provided innovative solutions for the DOD, federal research institutions, academic institutions, and various industries within the commercial sector. NASC areas of expertise include UAS design, development, manufacturing, and flight services, including UAS testing and evaluation, intelligence, surveillance and reconnaissance, hardware and software integration, testing and flight demonstration, payload integration and testing, and UAS flight training for all UAS classes of aircraft (Group 1 – Group 5). NASC flight service personnel include mission commanders, pilots, payload operators, flight instructors, and maintenance technicians - all employed in Pennsylvania.

NASC designs and manufactures multiple UAS platforms in the Group 3 through Group 5 category weighing between 300 and 1,800 pounds. NASC also designs, develops, and manufactures UAS ground control stations and additional mission support equipment. NASC provides around-the-clock cybersecurity, network management, and expertise in a broad range of product design, engineering, rapid prototyping, production, and manufacturing services. NASC also specializes in advanced acoustic research services in support of the Naval Air Systems Command, the Naval Air Warfare Center Aircraft Division, the Office of Naval Research, the Office of Naval Intelligence, the Naval Research Laboratory, the Naval Undersea Warfare Center, Naval Surface Warfare Center Dahlgren Division, the National Security Agency, the National Aeronautics and Space Administration, and other U.S. government organizations.

¹ <https://dod.defense.gov/UAS/>

UAS Promoted Growth for Important Work

NASC's addition of a full-service UAS line of business stimulated unprecedented expansion of the business. NASC personnel tasked with UAS engineering, manufacturing, and downrange flight services grew the company from 150 to 750 personnel in five years, with the majority of these personnel serving under government contracts in remote areas of operation outside the continental U.S. NASC's total investment for UAS, including facilities, manufacturing technologies, personnel, and training is in excess of \$50 million, most of which has been spent inside Pennsylvania. At their highest points, NASC UAS sectors alone employed 100 people within the state and another 600 forward deployed for various missions. When asked about the greatest benefit UAS has brought to the business, a senior NASC representative noted, "UAS has provided more high tech jobs and career opportunities so that our employees could support worldwide operations and programs for many new customers inside and outside of the U.S." This expanded customer base included, among others, utility, power and agricultural companies, law enforcement agencies, and public transportation agencies.

Conclusion

Navmar Applied Sciences Corporation has greatly benefited from adopting drone technology and manufacturing as one of its core business lines, resulting in extreme employee, revenue, and client growth. With the expansion in the UAS market, alongside new advancements in the UAS field, NASC has been able to significantly improve its original UAS products, as well as develop new ones to meet the many needs of their existing and new customers. Many of these successes are the direct result of NASC's Pennsylvania-based employees and operations.

UAS AND DRONE SOLUTION PROVIDERS

CASE STUDY

Drone solution companies offer a variety of aid to third-party businesses looking to adopt Uncrewed Aircraft Systems (UAS, or drone) technology in everyday proceedings. Drone-based solutions often specialize in the physical equipment itself, whether that be through selling, maintaining, or loading software and data to aid consumers with minimal knowledge of this innovative technology. Drone solutions cover every industry under the UAS umbrella. This case study highlights two Pennsylvania companies that promote drone advancement and productivity within third-party organizations, ConnexiCore and Tracer Drones Technologies.

Drone Companies are Offering Solutions and Aid Within Pennsylvania

ConnexiCore™ is a Milford, Pennsylvania-based UAS drone services and solutions provider. Their core business approach stems from managing the entire project process for their clients, from piloting the drones, analyzing the data, extracting insights, and delivering measurable and actionable tasks to supporting smarter decision making. ConnexiCore specializes in providing aerial drone data collection, image and video analytics, 3D modeling, video telepresence, and aerial mapping for a variety of industries. ConnexiCore has created a workflow for easier customer consumption.¹ Pilots have even conducted confined space inspections of sinkholes in crawlspaces using confined space drones. Recently, ConnexiCore has been using drones to provide large-scale structural inspections such as façade inspections for aging skyscrapers. ConnexiCore began in Pennsylvania in 2015 with the belief that drones were workforce multipliers, or so-called “tools in the toolbox” that could enhance multiple industries throughout the Commonwealth. Through this belief, ConnexiCore received an initial Ben Franklin Technology investment of \$100,000 on top of an initial \$500,000 investment made by its founders to expand their business. After a few short years, ConnexiCore has grown from four Federal Aviation Administration (FAA)-certified pilots to a pilot contractor network of over 1,200 and growing.

Tracer Drones Technologies is a drone sales and service organization working out of Lehigh Valley, Pennsylvania, that provides drone solutions to multiple industries such as agriculture, construction, and mining. Tracer Drones has also found a particular niche in the law, security, and fire world. This company specializes in aiding law enforcement, fire departments, non-governmental businesses, and security companies to conduct investigations, gather evidence, aid search and rescue initiatives, survey land, and patrol high-security areas through UAS surveillance and imaging. Tracer Drones uses UAS to service the public interest and public good and Tracer Drones aims to utilize their resources to influence companies to take the leap into adopting beneficial UAS technologies in everyday work. In addition to this, Tracer Drone provides maintenance services and repairs to protect drones already owned by third parties.² By offering their drone solutions, Tracer Drones educates organizations on the immense benefits of adopting and maintaining drone technologies. This company only expects growth in the future as businesses continuously adopt UAS technology and need the support in doing so.

¹ <https://connexicore.com/>

² <https://www.tracerdrone.com/pages/service-repairs>

There are a Multitude of Drivers Behind Drone Solution Companies

According to ConnexiCore, benefits of utilizing their services include cost savings, safety, and time reduction. For large-scale structural inspections, ConnexiCore scans every inch to inspect for anomalies. If anomalies go undetected, buildings can be severely compromised, adding increased cost and potential safety risks. To aid in time saving initiatives, ConnexiCore did a study for the City of Redding, Pennsylvania for a construction management company. In just two weeks, drone technology granted this construction company with a detailed map of every single parking spot in the city saving surveillance teams time, money, and reducing human interaction with unsafe conditions. ConnexiCore depicted everything from double-parked positioning to traffic blocks. Through its services, ConnexiCore ensures safety, efficiency, and a highly detailed product. According to a ConnexiCore spokesperson, "The biggest benefit for me personally, is the privilege of timing. We were able to leverage the technology to help people when the world was changing and there were a lot of on-the-job accidents and hazards. We help reduce such hazards while also offering a high-quality, beneficial service."

Tracer Drones highlights that their services aid in the reduction of costs and an increase in time savings for third-party agencies not equipped with UAS technology. For instance, before drone technologies, helicopters would be used for aerial surveillance in search of missing persons. Helicopters are extremely costly and purchasing one would come at a significant price to police and fire stations. However, drones are much more affordable and can be used for the same type of task. Agencies can afford multiple drones for the price of one helicopter to ensure that all investigations are fully equipped with aerial technology. Drones are also expected to last over a decade with minimal upkeep. Not only is UAS technology aiding in public safety, but also costs for businesses and government programs. Companies like Tracer Drones provide alternative solutions to allow maximum usage, safety, and affordability. As an example, a spokesperson of Tracer Drones describes the education of drones' benefits in multiple industries results in the adaptation of UAS technology: "I have found that every industry that we talk to, when you sit down and say, 'What are your pain points,' it usually comes down to time and money. When I discuss how drones have saved time and money in the past, eyes light up, and people start to get excited."

Conclusion

Drone solutions companies are influencing businesses in Pennsylvania and beyond in the adoption of UAS technology. ConnexiCore and Tracer Drone both report growth since their initial founding, and both companies expect a continuous need for solution providers. Such solution providers ensure UAS equipment maintenance, drone services, education, and sales of drone technology. It is expected that drone solutions providers remain a prominent member of Pennsylvania's UAS industry.

UAS AND EDUCATION

CASE STUDY

It is imperative that higher education institutions in Pennsylvania remain on the cutting edge of scientific and technological advancements to ensure Pennsylvania's students have opportunities to get hands-on experience in the technologies that will shape the future. One of the ways institutions are doing this is through the study and application of Uncrewed Aircraft Systems (UAS, or drones) into their curriculum. This includes supporting UAS-related research, providing opportunities for UAS pilot certification, and developing solutions for UAS advancement. This case study details how UAS application and research have been integrated into higher education institutions in Pennsylvania based on insight shared by a professor and director of the Center for Applied Environmental and Geospatial Technology (the Center) at Harrisburg University (HU) and by reviewing publicly available information on UAS programs at other higher education institutions in Pennsylvania.

New Research Opportunities Through UAS Advancement

As is evident in the work produced by the Center at HU, having UAS vehicles and the ability to operate them as part of a higher education institution brings about a variety of new and exciting research opportunities that would otherwise not be available. These opportunities include both external opportunities paid for by private grants and internal opportunities with research being funded by the university. UAS-related research grants give universities the opportunity to develop novel applications of the technology that may not be used elsewhere and be recognized for their contributions to advancing UAS application. These new research opportunities aren't just local, but global, and include research on mammal counts in national parks in Argentina, deploying multi-spectral sensors to conduct early-crop disease monitoring in Columbia, vegetation classification in Grand Cayman, and more. These UAS applications raise the profile of the university and increase the output of important research attributed to the institution.

Higher education institutions in Pennsylvania are not only applying UAS technology to their research, but they are actively working on advancing and optimizing the performance of UAS technology, as is evident in the work of the AirLab at the Robotics Institute at Carnegie Mellon University. The AirLab's mission is to advance state-of-the-art aerial autonomy, with recent research including advancing methods for object encoding, increasing energy productivity of first/last mile goods movement, developing lifelong loop closure detection, and more. AirLab is supported by a team of scientists, post-doctorate students, Ph.D. candidates, master's and undergraduate students, technicians, engineers, and interns. The AirLab is incredibly productive as is evident in their abundant research and presence at conferences. Most recently the AirLab had five papers accepted into the 2021 Institute of Electrical and Electronics Engineers (IEEE) International Conference on Robotics and Automation (ICRA) that took place in Xi'an, China.¹

UAS is Key for Student Recruitment and Engagement

Having a UAS or drone program has proven attractive to students that have an interest in cutting-edge technology. The HU representative estimated that more than half of the students in the Geospatial Technology program came to the University with a specific interest in UAS and learning how to use the technology,

¹ <http://theairlab.org/>

which is important as students in the program are required to conduct applied research during their time at the University. Students are given hands-on opportunities to participate in UAS-related research, particularly under research projects funded by the University. HU has a policy that at least two students must be on a research team for internally funded projects, creating opportunities for numerous students to participate. The Center at HU has seen increased student engagement with UAS advancements and applications, evidenced by the jump in attendance when the former “Geographic Informational System (GIS) Camp” was replaced with a “Drone Camp.” Standard operations at the Center prior to UAS inclusion were academics focused, teaching about geospatial technology, as opposed to the current program actually applying geospatial technology in a practical manner. HU is able to certify students, faculty, and staff in commercial drone operations through the University’s Federal Aviation Administration (FAA) Part 107 certification program and now HU has the ability to collect their own data to use in the classroom. This leads to hands-on activities using real-world data collected by HU compared to relying on sample data associated with purchased textbooks.

Interdisciplinary Coordination

There are four certified remote pilots that support UAS needs at HU. While these pilots are affiliated with the Center and the Geospatial Technology program, staff from a variety of departments have sought out or been involved in UAS-related work. Faculty and staff from the forensics, environmental science, interactive media, and biology departments, as well as other graduate researchers, have expressed an interest in, inquired after, or received assistance from the Geospatial Technology program and the Center’s UAS team to conduct various work. The level of interdisciplinary coordination will only continue to grow as different departments learn more about how drones can be used to benefit their programs or provide additional teaching opportunities.

Interdisciplinary efforts to advance UAS practices are also evident at Pennsylvania State University (Penn State) where an interdisciplinary UAS club has been established. The UAS club prototypes, designs, and builds autonomous drones, and gives students the opportunity to solve technical problems and learn by engineering systems for autonomous aircraft. The UAS club is involved in three subsystems of UAS advancements: the aeromechanical subsystem that focuses on designing and building the aircraft; the software subsystem that is responsible for designing and implementing various software components; and the electrical subsystem that designs and manages the electrical layout of the various digital components of UAS operations. The club is composed of aeromechanical, software, and electrical engineering students, and is overseen by three faculty advisors whose backgrounds are in aerospace engineering, computer science and engineering, and mechanical engineering.²

² <https://uas.engr.psu.edu/>

Conclusion

Higher education institutions in Pennsylvania are utilizing UAS technology for applied research opportunities and working to continually advance UAS capabilities through research and design efforts. These UAS application and advancement opportunities are not only attracting students from around the globe, but are also encouraging interdisciplinary coordination and increasing the recognition and profile of Pennsylvania’s higher education institutions in the UAS industry. UAS applications are the future for many industries and Pennsylvania higher education institutions are preparing students to make great contributions to the advancement and application of this technology.

UAS AND ENGINEERING

CASE STUDY

Businesses are realizing numerous efficiencies and new scopes of work with the introduction of Uncrewed Aircraft Systems (UAS, or drones) to support their traditional business practices. One of the industry sectors benefiting from UAS is engineering, which also often includes surveying and mapping. This type of work often requires extensive data collection and inspection of existing and new construction that can be facilitated by the use of UAS. The U.S. Department of Transportation recently noted that “Traditional surveying methods were often very dangerous...UAS can be used to collect data where it is dangerous or extremely difficult for a person to access...by utilizing UAS, we are able to collect high-quality survey data and minimize the time surveyors spend in dangerous situations.”

Pennsylvania’s businesses are taking note of this expanding industry and the opportunities offered through this evolving technology. Whether saving time and money, protecting the safety of staff, or retaining and attracting business, Pennsylvania’s engineering firms have found that UAS has enhanced their existing business practices and may open the door for further innovation. This case study details the findings and insights from two engineering firms headquartered in Pennsylvania, Rettew and Michael Baker International, Inc. (MBI)

Pennsylvania’s Businesses Are Investing in and Growing With UAS

Rettew is a mid-sized engineering company headquartered in Lancaster, Pennsylvania. Rettew has over 300 employees across 10 offices, with the majority of their employees based in Pennsylvania. Sixteen of Rettew’s employees are directly involved with their UAS program, which began five years ago and primarily supports Rettew’s existing services. All of Rettew’s UAS staff were trained and developed in-house, and a recent recommitment to growing their UAS program means that additional staff will likely become UAS pilots to support their program’s needs.

MBI is an engineering firm based in Pittsburgh with over 3,000 employees spread across nearly 100 offices in the U.S. As an MBI representative noted, “MBI has been using UAS since 2016 when it was initially adopted for bridge inspections. The firm is now up to 34 pilots and 32 drones spread throughout its offices. Since MBI has around 100 offices, this means that about a third of its offices have UAS.” MBI has seen increased use of drones within the firm since the initial days where they were used solely for bridge inspections. The MBI representative described UAS as a “tool in the toolbox...that enhances [existing] services.”

Both firms emphasized that employee retention and growth were a key part of their UAS strategies, and that existing employees have expressed interest in participating in UAS growth at their firms.

UAS Saves Time and Money and Enhances Services

Time and budget savings are the primary benefits that UAS affords engineering firms. Both Rettew and MBI reported conducting almost all of their UAS operations in-house. The one exception is LiDAR operations, which both firms contract out. The MBI representative reported that the use of UAS has reduced the time required for bridge tasks by 25 to 75 percent and reduced the time needed for surveying and mapping tasks by about 30 percent. The Rettew representative noted that prior to UAS implementation, a survey site could take five days to complete, whereas with UAS it now takes about half a day. He noted other advantages, including the ability to process a site in any weather at any time, allowing for the data development to be conducted in the office soon after.

In addition to time and cost savings, both firms recognize the value-added benefits that UAS can provide for traditional work efforts. For instance, the Rettew representative noted that “Drones have had a value for presentations when trying to win new client work. While Rettew hasn’t been hired solely because of drones, we are able to get visuals that make our presentations more engaging.” The MBI representative listed several benefits that UAS has added to existing business practices and deliverables within the firm, including “For mapping/surveying and surface data collection, UAS are more efficient than grid surveys and elevation data is more robust. For construction, [MBI] is able to collect real data from UAS.”

Conclusion

Pennsylvania’s engineering firms have benefitted greatly from the adoption of UAS into their regular business practices. Rettew and MBI are two engineering firms with deep roots in Pennsylvania whose businesses are continuing to grow and attribute some of the growth to the use of UAS. Both firms noted a continued investment in UAS in terms of training staff and purchasing equipment. Both firms were excited about the opportunities that UAS affords, including collecting additional and more accurate data, time and cost savings, scheduling advantages, and the opportunities for enhanced deliverables to impress clients and win more work.

UAS AND GOVERNMENT CASE STUDY

Government agencies are in a unique position when it comes to the widespread adoption of Uncrewed Aircraft Systems (UAS, or drones). Federal and state governments are responsible for regulating the use of drones, with the Federal Aviation Administration (FAA) responsible for regulating airspace and all aircraft operations, including drones. State governments are responsible for enforcing federal regulations and enacting any state-specific statutes that may protect the unique circumstances of that state. However, government agencies also benefit from the use of drones to conduct government work. For instance, PennDOT recently updated their UAS Policy document, which states that “PennDOT supports and will advance the deployment of UAS by PennDOT personnel and contractors to improve the quality, speed, safety, and cost-effectiveness of PennDOT’s work and recognizes the potential for UAS utilization to advance road surveys, geotechnical investigations, traffic modeling, bridge inspections, and other PennDOT projects.”¹ In other words, governmental agencies both are responsible for regulating drones and use drones in the normal course of doing government business.

Government agencies play one of the most important roles in the increased development of the UAS industry. This case study outlines the role of PennDOT’s Bureau of Aviation (BOA) in UAS regulation, development, and use.

Pennsylvania is Focused on Regulation for Safe and Efficient Drone Use

When it comes to integrating UAS into the Commonwealth, Pennsylvania’s focus has consistently been on safety. Multiple efforts have been conducted and others are underway to set up a governance structure to achieve this goal. The Director of the BOA stated that the development of the department’s UAS Policy document began as early as 2017 when discussions surrounding UAS and safety started to happen on a statewide level. “For the most part, [UAS governance] resides in the state’s aeronautics or aviation department. Pennsylvania’s state government created a UAS Task Force...which is in the process of developing a plan to integrate UAS into the Commonwealth,” he noted. There are multiple committees on this Task Force, with some notable ones being safety, economic development, and urban air mobility (UAM). This Task Force will hopefully ultimately result in the creation of a UAS Program Center within PennDOT, where UAS governance and use within the Commonwealth will be centralized and where Pennsylvania can provide assistance to other Commonwealth agencies, local governments, and other states.

¹ PennDOT, Unmanned Aircraft System (UAS) Policy, <https://www.paconstructors.org/wp-content/uploads/2019/06/PennDOT-UAS-Policy-Ver-1.0Apr2019.pdf>

Government Work is Safer, Faster, and More Efficient With Drones

PennDOT BOA is currently and is expected to remain responsible for UAS regulation at the statewide level. This includes UAS usage in the course of doing government business. The PennDOT BOA Director noted that “BOA developed the policy document for drone operations, specifically for [PennDOT] employees to be pilots... [an exam was also developed] for PennDOT employees, and if they pass they can operate drones on behalf of PennDOT.” While no one in the department is currently fully dedicated to UAS, PennDOT has 14 employees and 76 contract employees that are certified to fly drones on behalf of PennDOT. The PennDOT BOA Director added that UAS are currently used primarily for construction, design, survey, and evaluation of landslides, and bridge inspections.

PennDOT also has one drone coordinator per District who is responsible for coordinating UAS activities with remote pilots and an individual in charge of the operation. There are typically two employees deployed for each UAS mission, a pilot, and a mission assistant. PennDOT has realized about a 20 percent reduction in costs due to conducting routine department work with drones instead of traditional methods. Not only does UAS provide safety and time savings but provides enhancements to public participation. The PennDOT BOA Director noted that drones are used in developing “renderings of future projects that can be shared with the public to showcase what [PennDOT] projects look like...the public sees a value in that.”

Conclusion

UAS has touched every facet of the aviation industry, including government oversight and implementation of government duties. As the FAA continues to regulate drones to maintain the safety of the airspace while also encouraging their development, state governments must both enforce federal regulations while developing their own state policies. PennDOT BOA has a large role in ensuring drones are integrated into the Commonwealth in a safe and efficient manner. At the same time, PennDOT and its consultants are realizing the time, cost, and safety benefits of using drones to complete government work.

UAS AND INSURANCE

CASE STUDY

As the benefits of Uncrewed Aircraft Systems (UAS, or drone) technologies are becoming more recognized, drones are being readily integrated into multiple industries. Recently, insurance companies have begun utilizing drone technology capabilities through complex imaging, on-site measurements, damage detection, 3-D models, and in-depth data collection of claims. This case study details one Pennsylvania insurance company using UAS to improve its operation.

UAS are Revolutionizing Pennsylvania's Insurance Industry

In Pennsylvania, one large insurance company has taken the successful leap to include UAS technology in insurance operations. According to the company, they are using drones to get clear and detailed images of property damage in difficult-to-access areas, enabling their claims staff to focus on taking care of their customers with personal service.

This company is among the first insurance companies to not only insure personally owned drones but to also use drones to assist in property damage claims. They have received permission from the Federal Aviation Administration (FAA) to use drones commercially. Currently, they utilize small drones (less than 55lbs) to perform structural inspections for risk control and claim adjustments. The company has already invested an estimated \$150,000 in UAS and has upwards of 50 FAA-licensed pilots and 2,300 claims employees based in Pennsylvania.

The first claim for which they used drone technology was to examine a roof after ice damage. The aerial images taken were then compared to the claim adjuster's original photos for clarity and certainty. This example demonstrates the simple improvements being made through drone technology. Precise, aerial imaging grasps the full picture of the damage benefiting both the customers and the claim adjusters.

¹ <https://www.erieinsurance.com/news-room/press-releases/2015/drone>

Drones Increase Safety and Efficiency of Inspections

The greatest benefits UAS have provided to this insurer are safety and efficiency of inspections. For example, prior to UAS, employee inspections of roofs were conducted using large ladders or ropes, and some roofs were too dangerous for adjusters to inspect. However, drones are now used to help adjusters survey potential damage without putting themselves in danger. Drone technology has aided in reducing the risk of workers being placed in dangerous settings that could lead to further damage. While the use of UAS has improved safety, it has not reduced the company's overall workload. Instead, the incorporation of UAS reduces the time the workload takes. UAS technology adds efficiency to collecting claim data by cutting the time taken in half to gather more detailed information. The data gathered is then digitized and added to existing information for the entire claims process. It is important to note that drone technology does not result in jobs being lost or work being replaced. Rather, jobs and work are being added to improve the overall quality of inspections. In the previous roof example, drones did not replace the claim adjuster's job, drones were used to add information (including initial collection that may otherwise have been impossible or unsafe for a human to collect) or certify information already gathered by the claim adjuster. The efficiency offered by drone technology is not only useful to the insurance provider, but also to the individual filing a claim.

Conclusion

Through the adoption of UAS into their everyday business practices, insurance agencies like Erie Insurance are operating more safely and efficiently to provide quality, timely service to their customers. No longer do employees have to enter dangerous conditions in order to complete their tasks. Now, drones are able to complete dangerous tasks and leave employees free to concentrate on customer service and other aspects of the business. UAS are not replacing jobs, but rather creating more opportunities for work.

UAS AND MINING

CASE STUDY

Uncrewed Aircraft Systems (UAS, or drones) in Pennsylvania are being used to assist in surveillance, monitoring, and aerial imaging now more than ever. However, one of the most notable and fascinating ways they are being used is not above our heads, but rather, below our feet. UAS technology is advancing and revolutionizing the way precious stones, metals, and more are being mined.

Since 1775, Pennsylvania miners have descended into the dark to face unknown hazardous environments. Today, UAS, along with spatial and mapping computations, can be deployed to explore the most complex, dark, and dangerous environments.¹ Whereas safety teams and miners historically have risked surveying these underground environments on foot before beginning work, drones can now map out entire mining systems with precise 3-D imaging in just four to eight hours. This case study highlights one Pennsylvania-based company using UAS to advance mining operations, Exyn.

Interest is Growing for Using UAS in the Mining Industry

Exyn Technologies is a Philadelphia-based company that formed out of the University of Pennsylvania's General Robotics, Automation, Sensing & Perception (GRASP) Lab in 2014. With over 100 employees, Exyn has doubled in size within the last year, and within the next year is expected to double in size again. Currently, Exyn has conducted business on every continent except Antarctica and has invested millions into hiring Pennsylvania employees and students. Partners of Exyn include Optron in South Africa, NSS Canada, C.R. Kennedy company in Australia, World Class Mining in Mexico, Sandvik in Finland, and many more.

Exyn is an international UAS business that provides drone hardware and software for UAS. Their technology includes the ExynAero drone, which launches at the press of a button and navigates pilot-free through an entire stope of a mine in a single flight, and the Exyn AI drone, which is immune to GPS loss and is regarded as the highest-level aerial autonomy reached within the industry (Level 4A autonomy). This company's technology is crucial for the mining industry as, "Oftentimes the information [needed] is beyond the line of sight, and out of communication range."

¹ Exyn Technologies, <https://www.exyn.com/>

UAS Enhances Safety and Efficiency in the Mining Industry

Exyn's pilot-free drones and portable ground systems deliver precise 3-D maps, sensor data, and georeferenced models to the mining industry. Generating more precise data allows personnel and rescue teams to have better visibility and understanding of the environment without descending miles into unseen terrain. No longer do teams need to map out mines by foot; a drone can complete this task in just a few short hours. Using drone technology, mapping of mines is done quicker and safer than ever; as a Exyn representative stated, "We're keeping personnel and rescue teams out of dangerous environments— we're saving lives."

Conclusion

Exyn is a thriving Pennsylvania-based business that specializes in the immensely difficult: safer mining. This company's advancements in technology are only beginning, and the use of UAS for mining activity is only growing. By producing drones that can intelligently navigate and dynamically adapt to complex environments in real-time, Exyn furthering a revolution in autonomous robotics.

UAS AND MULTIMEDIA

CASE STUDY

Multimedia is an industry that specializes in the production and publication of media-based information, including text materials, photographs and still images, audio files, video presentations, and animation.¹ Uncrewed Aircraft Systems (UAS, or drone) technology is incorporated within every element of the media industry. Drones have been utilized to access higher-quality visual aids to share precise, appealing information to the general public. Pennsylvania companies are at the forefront of the integration between multimedia and drones. This case study examines Kaze Aerial and CBS 21, two multimedia broadcasting companies that use drone technology to produce high-quality visual information sharing.

Pennsylvania's Multimedia Companies Have Seen Huge Successes

Kaze Aerial (Kaze) was one of the early adopters of drone technology and started using UAS in 2011. Kaze, a Philadelphia, Pennsylvania-based company, is a broadcast and media company that specializes in utilizing UAS photography and video. Kaze is owned by three individuals and hires drone pilot contractors for specific jobs.² Each job typically requires two to seven licensed pilots to carry out. The company is quickly approaching \$1M in gross revenue and has invested over \$700,000 in the UAS industry. In 2020, the company grew by 115 percent; in 2021, they grew by 276 percent.

Kaze has expanded to provide services for the highest level of sports broadcasting and commercial operations. Kaze works with notable platforms including CBS Sports, ESPN, Fox Sports, PGA Champs, and the Masters in Augusta. They work in both the private and public sectors in highly exclusive venues. Due to these venue types, Kaze has applied for waivers of operation at the local, state, and federal levels to fly their aerial imaging drones. Kaze was third in the United States, after CNN, to be granted permission by the Federal Aviation Administration (FAA) to fly over people (FAA Part 107.39 waiver). According to the Kaze spokesperson, "Our business is entirely built on UAS technology."

CBS 21 is a local news broadcasting station in Harrisburg, Pennsylvania that began using UAS technology in 2016. CBS 21's parent company, the Sinclair group, utilizes drone technology in about 45 different stations with 120 certified pilots across the United States. CBS 21 has two drone pilots and five visual observers and expects this number to increase as viewer interaction with UAS technology increases. Contextual information through aerial imaging has increased viewer satisfaction and engagement which has added to the growth of the station. In total, CBS 21 has invested about \$60,000 in UAS technology and plans on expanding this technology further. Drone pilots are beta testing single-person flights to increase efficiency. In Harrisburg alone, CBS 21 has flown over 3,200 flights since program implementation.

¹ <https://smallbusiness.chron.com/5-components-multimedia-28279.html>

² <http://kazeaerial.com/https://smallbusiness.chron.com/5-components-multimedia-28279.html>

UAS Technology Provides Numerous Innovations

According to Kaze, drone technology has enhanced sports broadcasting and allowed famous courses and venues to be seen by fans like they've never been seen before. In sports like golf, shooting coverage is heightened as aerial views can cover the entire course. Imaging is then posted on social platforms that promote fan support and fan interaction. The Kaze spokesperson noted, "Drones offer a return on investment because they are sensational. They create a sensation of the game, of the venue." Ultimately, UAS imaging benefits the venues as they serve to market the game and the venue in a new and intriguing way. In terms of operation, drones are cost-effective. Instead of blimps and helicopters, which can cost thousands to tens of thousands of dollars per flight, drones serve as substantially less costly alternatives.

CBS 21 utilizes drone technology to not only enhance services already being provided, but also to offer additional services for news coverage, high-quality aerial footage, and context to their stories. For example, stories surrounding landmarks, buildings, and construction zones can use UAS to zoom immediately from the reporter to the area of interest to give viewers contextual evidence of the news story. Overall, the product delivered to the audience is enhanced. Aerial imaging offers perspectives and views that engage and infatuate viewers. According to a CBS 21 spokesperson, "Drone videos keep our clients happy, and we try to get footage every day. UAS, overall, has really enhanced our product." In examples like natural disasters, drones allow broadcasters to gain better insight for more informed coverage of areas too dangerous to reach on foot. Recently, CBS 21 covered flooding in the region and used UAS footage to educate viewers on safety precautions and dangerous areas.

³ <http://kazeaerial.com/> <https://local21news.com/>

Conclusion

Kaze Aerial and CBS 21 specialize in very different forms of media broadcasting but have both found benefit in the utilization of drone technology. Both companies use UAS to engage viewers and tell a better story of the event being recorded. Both companies expect a continuous and growing use of drone technology in the future and have significantly changed the way they do business due to UAS emergence.

UAS AND OIL AND GAS CASE STUDY

One of the primary benefits of using Uncrewed Aircraft Systems (UAS, or drones) in everyday business practices is their aerial imaging and data capabilities. These capabilities are useful to a variety of industries and businesses and have far-reaching implications. Continuous data collection influences businesses' decision-making related to investment, safety, and construction of assets. Drones have replaced traditional surveying methods to provide more data in a fraction of the time. This case study highlights one Pennsylvania company using UAS to collect and process asset data for the oil and gas industry, Eyebot Aerial Solutions (Eyebot).

Advances in Data Collection Aid Pennsylvania's Oil and Gas Industry

Eyebot was founded in 2018 in Pittsburgh, three years after the Federal Aviation Administration (FAA) allowed commercial drone operations. Eyebot currently employs 11 full-time local staff and has \$350,000 in physical assets. Eyebot focuses its data collection work in the oil and gas, engineering, and chemical industries. Eyebot uses UAS to collect and process 3-D data to help decision-making processes around critical assets in infrastructure, heavy industry, and construction for large oil and gas companies. These 3-D models create a digital representation of the interior and exterior of critical assets and reduce field time by 90 percent and costs by 50 percent. Eyebot also delivers data such as surveys, photogrammetry, LiDAR, and topographical surveying, developing engineering datasets that coincide with software applications already owned and used by their clients. According to Eyebot, "Our extensive expertise working with industry-leading software allows us to engineer secure, efficient workflows that snap seamlessly into their existing operations."

For the last three and a half years, Eyebot has collected data for Pennsylvania Chemical's petrochemical facility. Every data sample that emerged from the ground is collected through drone observation. These data are then delivered in 2-D and 3-D products. Eyebot also worked for Pennsylvania Chemical to deliver confined space inspections, ground-based laser scans, mobile mapping systems, and terrestrial laser scanning.

Data allows for improvements in everyday operations

According to an Eyebot spokesperson, this data collection makes people's jobs easier without replacing actual paychecks: "We don't replace the inspector, we just replace the ladder." Increases in data collection correlates to increased safety, efficiency, and accuracy of a product. Safety is a key theme that Eyebot highlights. For example, by developing a 3-D model of a dam's face, these data are made accessible to any of the stakeholders that are in charge of the decision-making process around that dam. A person conducting work or inspection could simply follow a link and click on any point along the face of that dam to pull up source imagery. This source imagery displays any potential danger and can be referenced to understand how to conduct work safer, faster, easier, and more efficiently. Additionally, as the Eyebot spokesperson noted, "keeping people safer isn't something that you can place a dollar value on."

Conclusion

Eyebot is a company that is directly tied to the emergence of drone technology. Clients have reported experiencing the positive implications of shorter field time and decreased costs. Eyebot does not replace inspection jobs but rather works with examiners to ensure that they have all the tools available to them to come to the most accurate and informed conclusion. The data and software utilized by drone technologies are crucial tools in ensuring safety, efficiency, and accuracy of tasks. Human error and risk associated with in-person inspections and surveying of oil and gas companies' infrastructure and assets are mitigated through this data collection.

UAS AND PUBLIC SAFETY

CASE STUDY

Public safety refers to the protection of the general public's welfare. Uncrewed Aircraft Systems (UAS, or drones) are being deployed across Pennsylvania to maintain and enhance the social and public good. This includes search and rescue missions, monitoring large venues and parks, and surveying potentially dangerous areas. This case study focuses on Unmanned Response, a Pennsylvania-based UAS company that focuses solely on the integration of UAS into public safety operations.

Pennsylvania's UAS Industry Specializes in Public Safety

Unmanned Response specializes in providing drone services for search and rescue, situational awareness, intel, surveillance, and recon (ISR), public relations, recruitment, and more. The company has a wide range of clients, including community organizations, infrastructure companies, insurance companies, educational institutions, and institutions in the criminal justice system. Unmanned Response's founders believe that "Drone technology and increasing education of this technology is crucial for ensuring public safety and maintaining the public good."

Unmanned Response began as the Community Resource Corporation, which was not a primarily UAS-based company. Early on in Community Resource Corporation's beginning, the founder utilized remote control hobby helicopters to execute a particularly difficult high-altitude business endeavor and discovered the efficiency, safety, and accuracy of using UAS for business operations. Founded in 2013 and based in Pittsburgh, Unmanned Response currently operates about 15 drones, with access to another 30 to 40 from outside organizations. All drones used are under 55 pounds and are equipped to perform public safety-oriented tasks, such as search and rescue, surveillance and recon, and aid in foot pursuits. All drone operations are in-house, and most, if not all, of the company's 22 employees have experience as first responders, whether that be as former police officers, emergency medical technicians (EMTs), or firefighters. Unmanned Response has an estimated total of \$150,000 invested in UAS.

Unmanned Response Educates Public Safety Organizations

Through their experience with public safety-related drone operations, Unmanned Response is able to educate other agencies that are aiming to incorporate UAS into their business operations. For instance, Unmanned Response recently completed drone piloting prep tests with Cranberry Township Police and Fire Departments. Further, Unmanned Response employees have taught the integration of public safety and UAS technology at Pierpont University, West Virginia University, California University, and the Community College of Beaver

¹ <https://www.unmannedresponse.com/>

County. Lessons cover the usefulness of drone technology for multiple public safety situations, including how to use drones for crime scene investigation and documentation.

According to an Unmanned Response representative, the company has acquired expertise in locating clandestine (or unknown/unrecorded) grave sites, working on cold cases, and analyzing homicide scenes. The implementation of drone imaging technology in crime scene investigations ensures the preservation of the physical evidence on the scene. In cooperation with local law enforcement agencies, Unmanned Response has flown drones over crime scenes before the police have even examined them to not only survey and analyze but to ensure the integrity of the scene. A variety of UAS sensors and imaging technologies are advancing crime scene analysis. Such technology can also be used to document fires, reconstruct car crashes, and follow and apprehend armed suspects.

Conclusion

Companies like Unmanned Response are fueling best practice programs and initiatives with drone response education and UAS-based aid. Unmanned Response is serving local entities, like first responders and private companies by providing numerous services, including surveillance and imaging of potentially hazardous areas. This ultimately helps to protect public safety and ensure that trained specialists are available and prepared when needed.

UAS AND REAL ESTATE

CASE STUDY

The real estate industry is diverse and divided into types including residential, commercial, industrial, and land. Residential agents specialize in selling homes and apartments while commercial and industrial agents operate in sales for businesses. Uncrewed Aircraft Systems (UAS, or drone) technology is utilized by the real estate industry to provide new, unique perspectives of properties for clients. UAS technology provides all sectors of the industry with overhead imaging to capture the entire home, storefront, manufacturing facility, land, and surrounding areas. This detailed imaging, including potential 360-degree panoramas and videos, provides buyers with additional context to make the most informed decision when buying property. This case study details how one Pennsylvania real estate business is utilizing UAS applications, 360 Aerial Tours.

A Pennsylvania-Based Real Estate Business Provides Innovation in the Industry

360 Tour Designs began in 2009 in Mechanicsburg, Pennsylvania as a real estate photography company. In 2012, the company integrated drone aerial imaging into its business model. Before drone pilot licensing was easily accessible, 360 Tour Designs worked directly with the Federal Aviation Administration (FAA) to petition for the approval to incorporate and fly drones for their company. In 2015, 360 Tour Designs grew into a franchise and established a presence in other states. 360 Tour Designs estimates a total investment of \$7,000 per year in UAS technology. The company is equipped with seven Phantom 4 drones which weigh about three to four pounds and offer high air stability for optimal imaging despite wind speeds. The company also has six certified Pennsylvania-based pilots who undergo a three-month, intensive training to maintain 360 Drone Designs' 100 percent safety record.

As 60 to 70 percent of buyers today look at homes online, 360 Tour Designs aids realtors and business owners in selling themselves and their properties.¹ With over 400 flight hours logged, 360 Tour Designs' aerial imaging offers innovative marketing methods to match realtor with buyer. This aerial imaging goes above and beyond to inform potential buyers of property characteristics. For imaging of large areas of land, editors can take a tax map and overlay the property lines. For residential areas, 360 Tour Designs' drones give buyers a bird's eye view of areas around the location such as neighboring properties, stores, and bodies of water. According to a company spokesperson, "What is most important is to have buyers be interested in visiting the property. Our imaging informs and entices potential buyers and sells properties." 360 Tour Designs of Pennsylvania estimates providing services for five to seven properties a day based on their record in October and November 2021.

¹ <https://web.360tourdesigns.com/>

Growth Through UAS Incorporation

360 Tour Designs opened its second location in 2015 and since has franchised and grown into fifteen different locations across the United States. Current 360 Tour Design locations include Portland, Oregon; Salt Lake City, Utah; Indianapolis, Indiana; Houston, Texas, and more. 360 Tour Designs estimates a 300 percent increase in revenue growth since 2015. Drone technology continuously aids revenue streams through client interest, client growth, and retention. According to a company spokesperson, "Without drone technology, I'm quite sure we wouldn't be where we are today as a leader in our industry."

Not only has the company grown nationally, but the Pennsylvania headquarters expects continuous growth within the state. Growth is not only expected through increased client interest in the real estate sector but by 2022, this company expects to add thermal imaging qualities to each drone to expand into other industries such as forensics. 360 Tour Designs expects to add one to two pilots a year due to continuous real estate growth and this number is expected to double when thermal imaging is successfully equipped in their UAS technology.

Conclusion

Drones incorporated in the real estate industry offer realtors with new, innovative marketing methods, and offer buyers full, detailed information on properties. UAS utilization is expected to continue to grow within the industry as client interest expands. Businesses such as 360 Tour Designs that are adapting drones into their business model are benefitting greatly from their increased ability to satisfy their customers. As business opportunities and clientele continue to expand, UAS advancement and use within the Pennsylvania real estate industry is expected to also grow.

UAS AND SERVICE PROVIDERS

CASE STUDY

As the Uncrewed Aircraft Systems (UAS, or drones) industry grows exponentially, UAS-centered companies are needed to provide multitudes of services to third parties. Drone service providing companies can be likened to an umbrella that specializes in the versatility, adaptability, and advancement of drones and drone technology. Services include aerial inspection, utility aid, survey and mapping support, data management, safety/security support, equipment maintenance, purchasing advice, and even delivery. This case study highlights two companies that serve as drone service providers in Pennsylvania: Argos Unmanned Aerial Solutions and Drone Base.

UAS Service Providers Flourishing in Pennsylvania

Argos Unmanned Aerial Solutions is a service-disabled veteran-owned drone service providing company that started in Pennsylvania in 2015. Argos' primary market is to service the operations of drones or use their own fleet of drones as a service within the region, specializing in utilities and surveys for large industrial and infrastructure companies. Locally in Pennsylvania, and regionally in New York, New Jersey, Delaware, and Maryland, Argos focuses on survey mapping work. Nationally, they offer utility inspection support services. Argos has flown over 3,800 flights and has invested over \$250,000 in UAS technology. Comprised of three business partners and six Federal Aviation Administration (FAA) Part 107 pilots, this company is a part of a larger ecosystem of drone-related services; Argos also partners with other UAS companies. Argos will fly their drones to capture data and then hire another company to process and return the data to their client, creating a mutually beneficial relationship.

Headquartered in California, Drone Base employs over 80,000 registered drone pilots; 10,000 of these pilots are located in Pennsylvania. Drone Base is primarily involved in the AEC (Agriculture, Engineering, and Construction) industry and delivers intelligent aerial imaging for high-value infrastructure. This includes anything from a wind turbine, to solar panels, to roofing projects.¹ Utilizing drone technology, Drone Base provides aerial data and analysis to companies to identify anomalies. These data serve as a constant pipeline to observe the condition of companies' assets (both energy-producing assets and material assets). Data analysis from drones reduces the risk of damage or disruptions that can ultimately harm businesses in the long run. A partner of Drone Base is Lindy Paving, a company that paves 60 to 70 percent of Pennsylvania's roadways. Drone Base's pilots analyze the progression of these paving projects to discover both safety areas when building the roadways and the most geographically feasible routes by tracking topography.

¹ <https://dronebase.com/>

Drone Service Providers Provide Numerous Benefits

Before UAS technology, inspections of transmission towers that are currently provided by Argos were executed through two methods. These methods included climbing the tower with a rope or hanging out of a helicopter. For surveying, a typical job for Argos is over a hundred acres. Before drone technology, this area was walked on foot, taking weeks to months to complete. In both niches, Argos has implemented drone technology to ensure efficiency, safety, speed, and accuracy. Inspections are completed with humans on the ground; month-long surveying only takes half a day. Pilots are able to manually control multi-rotor drones in the most extreme locations.² Safety, efficiency, and accuracy are selling points that continue to provide constant revenue, and flights, for Argos.

According to a spokesperson for Drone Base, “Our ultimate goal is to help our customers recover revenue through anomaly identification and reduce risk of damage.” Aerial imaging during the construction phase improves decision making and provides more insight into the project as a whole. Additionally, it increases the safety and efficiency of inspections. For instance, Drone Base inspects roofs for residential and commercial properties. This work is done quickly and efficiently with drones while also reducing the risk of injuries associated with using ladders and working at tall heights, as is used during a traditional inspection. Human risk is decreased, time is saved, and accuracy is increased, ultimately resulting in increased revenues for companies who utilize Drone Base technologies.

² <https://www.argosuas.com/>

Conclusion

Both Argos and Drone Base have reported rapid expansion in the last few years. Both companies are benefitting multitudes of companies with their services. Their services provide the safety, efficiency, and accuracy needed to reduce loss and increase revenue. Customers of these drone service providers report high satisfaction and desire to continue the mutually beneficial relationships; both companies reported continuous new client interest. As Argos is a Pennsylvania-based company, and Drone Base employs 10,000 Pennsylvania-based employees, the future of Pennsylvania’s drone service industry is strong and is expected to continue to see notable growth.

UAS AND STANDARDIZATION

CASE STUDY

Industry standards refer to voluntary agreed-upon practices, values, and safety precautions that establish requirements per industry. For example, in the Uncrewed Aircraft Systems (UAS, or drone) industry, one standard includes “minimum requirements for an Unmanned Aircraft Flight Manual (UFM) for a ...UAS designed, manufactured, and operated in the light UAS category as defined by a Civil Aviation Authority (CAA).”¹ Standards are important to maintain a high level of professionalism, safety, and product integrity for consumer and business use. This case study details ASTM International, a Pennsylvania-based international organization that develops safety and performance standards, including those for UAS.

Pennsylvania is the Headquarters for an International Organization

ASTM International (ASTM) is headquartered in West Conshohocken, Pennsylvania, with the headquarters alone employing over 200 employees. In addition to its headquarters, ASTM International has offices in Washington, D.C. and around the world including Belgium, Canada, China, and Peru. ASTM is a voluntary consensus standards organization, formed in 1898, with over 12,900 standards and more than 145 technical committees that represent over 90 industry sectors including concrete, additive manufacturing, and commercial spaceflight. These technical committees are made up of 32,000 volunteer members who come from more than 140 countries around the world and serve as the technical experts who develop standards. With five specific aerospace sectors, the F38 Committee on Uncrewed Aircraft Systems (started in 2003 as a Memorandum of Understanding with the Federal Aviation Administration [FAA]), includes three subcommittees: the airworthiness subcommittee (F38.01), the flight operations subcommittee (F38.02), and the subcommittee on personnel training, qualification, and certification (F38.03).

Current Pennsylvania companies involved in the ASTM F38 committee include Near Earth Autonomy (profiled in the UAM/UTM Case Study), Asylon, One Sky (profiled in the UAM/UTM Case Study), Sullivan Aviation, Piasecki Aircraft Corporation, and Icarus Aerospace.

¹ <https://www.astm.org/f2908-18.html>

Standardization is Helping the UAS Industry Grow

There are currently 520 members within the F38 committee. Through this main committee and its three subcommittees, standards are developed for UAS technology, minimum safety, performance, flight proficiency requirements, quality assurance, methods for monitoring and maintaining continued operational safety, and processes for identifying, reporting, and remedying safety-of-flight issues. ASTM International is industry-driven, meaning that any individual or company, including manufacturers, consumers, and general interest individuals within the UAS industry, can propose standards to the F38 committee. All ASTM standards follow ASTM's consensus-driven approach, meaning everyone has a voice in the process. Currently, the F38 committee has 27 approved standards. These standards are often used as a basis for law, regulation, or a means of compliance to show that a platform, system, or service can operate safely within the national airspace. A current initiative of ASTM is the Remote ID and Tracking Standard. This standard is expected to appease the growing demand for better identification and tracking for drones.²

² <https://www.astm.org/get-involved/technical-committees/committee-f38/subcommittee-f38>

Conclusion

ASTM International is a renowned global standards organization that relies on the needs and recommendations of individuals and companies. ASTM employs hundreds of Pennsylvania-based staff to drive this international initiative. Involvement in the UAS standardization process is open to all individuals. ASTM continuously works to ensure that UAS standards are necessary and beneficial to the public. Current Pennsylvania organizations are part of F38, and ASTM International expects more involvement as drone businesses continue to grow and flourish in the Commonwealth.

UAS AND TELECOMMUNICATION

CASE STUDY

Telecommunication is the long-distance transmission of information using technology such as wire and radio. This information is sent over a network and can be in the form of text, data, imaging, and more. As Uncrewed Aircraft Systems (UAS, or drones) have become a prominent method for aerial imaging, companies are discovering the possible synergy between telecommunication and drone technology. This case study highlights a Pennsylvania-based company, Rajant Corporation, combining drone technology, radio technology, and mesh technology to ensure connection and communication in even the most extreme environments.

A Pennsylvania-Based Firm is Revolutionizing Mesh Technology

Rajant, based in Malvern, Pennsylvania, is a 150-employee company specializing in wireless networks which provide fully mobile broadband connectivity that is self-optimizing and self-healing to move and evolve with application demands. This connectivity is fully distributed and maintains many connections simultaneously, affirming that connecting to a network is constantly possible.

For the last 20 years, Rajant has specialized in enabling connectivity in remote places. Deep into underground mines, across congested ports, and across vast agricultural expanses are a few examples of Rajant's missions. A spokesperson stated that Rajant is "a company in the vehicular communications world." Simple techniques of affixing a Rajant radio node allow trucks and other industrial equipment to have perpetual, moving networks in non-connected areas.

From its beginning, Rajant has worked with the military, utilizing its architecture for defense communication projects. Rajant has carried those successes into industrial and commercial markets. This Pennsylvania-based company has expanded to service national, military, and international interests over the last 20 years.

UAS is Helping the Mesh Technology Field Grow

Recently, Rajant has intertwined drone technology and mesh technology to demonstrate the power of connectivity. Utilizing radio technology, Rajant can deploy multiple drones, referred to as “swarms” or “large-fleet operations,” interconnected to communicate with each other to accomplish a common goal. A single person controls the entire fleet of drones and the onboard cameras. In Greece, Rajant used its mesh technology and underwater drones to map parts of the ocean. For the military, Rajant places a radio node on every drone (over 100 drones in total) to survey potentially dangerous areas before soldier engagement. In both examples, connectivity was attained in areas with little to no network enabling inter-communication and data collection through multiple drones.

Rajant also demonstrates how one singular drone can improve connectivity between people and areas. During concerts, the Fourth of July, and other major events in Pennsylvania, Rajant has used drones to mimic a cell tower to provide additional bandwidth. A ground generator powers a cable up to the drone to feed longer air time. In large groups, where cellular connectivity dwindles, drones give the height needed to cover the greater geography of users.

Another application of mesh technology includes connecting miners operating deep underground or tunneling through mountains. Real-time connectivity for safety and productivity is mission critical. Often these miners are working with explosive material, and a lack of communication between teams can be hazardous. Rajant will place a drone on top of the mountain to connect miners below with no infrastructure required. The drone acts as part of the network to feed data to the central command.

Conclusion

In the last few years since the company began implementing UAS technology, Rajant has already experienced high positive revenue due to its mesh and drone integration. Rajant attributes much of this revenue to the ability for drones to communicate with each other to finish a given task. As demand for Rajant’s technology grows and as new clients continue to adopt this drone methodology, Rajant’s UAS operations have become a crucial aspect of its business and partnerships. Rajant expects future growth as their UAS operations and capabilities increase.

UAS AND TRAINING

CASE STUDY

Interest in owning and flying Uncrewed Aircraft Systems (UAS, or drones) is increasing as UAS technology advances and UAS are made readily available. Whether that interest be for a hobby or a career, training opportunities and programs are necessary to ensure that operators and pilots can fly their drones safely while complying with airspace rules and regulations. This case study profiles a Philadelphia-based company that provides UAS training, Master Your Drone.¹

UAS Hobbyists Find New Passions

Master Your Drone, a Philadelphia-based drone school, provides experienced teachers and safe environments to explore UAS. The company has already invested over \$100,000 in UAS technology to teach precision and confidence to drone students. Lessons include drone flight operations, visual observer training, Federal Aviation Administration (FAA) rules, weather, regulations training, hands-on drone flight exposure, obstacle courses, applications and drone insurance recommendations, and drone job skills training. According to the CEO of Master Your Drone, “We get people as young as 11. Parents are looking for something different, something exciting to do with their kids. What I love about drones is that they’re not competitive. You can just have fun. I just want people to fly, fly, fly, and be inspired.” Master Your Drones works with a wide variety of people, from young adults looking to find a passion, to retirees looking for a new hobby. The main goal is to teach responsible and safe drone usage. A team of eight instructors teaches a 30-point skill set to each student. For every instructor, there are two students and there is a 10-person limit for every class. First, students are taken through drone simulators, then to an indoor course to master remote control, and finally outside to learn aerial and video photography. Master Your Drone typically provides drones to beginning students so as to not exclude those who want to learn but who do not have their own personal drone yet.

¹ <https://masteryourdrone.com/>

Master Your Drone is Training the Next Generation of Commercial Operators

Although Master Your Drone offers a variety of packages for different interests, the drone master class is targeted to those looking to become a certified FAA Part 107 pilot and integrate into the pilot network within Pennsylvania. Instructors provide a step-by-step course in airspace regulation and the segments of Part 107 needed to acquire certification. In the last four years, Master Your Drone instructors trained over 200 Part 107 pilots, with the highest percentage of these being trained just within the last year, showing a growing interest in this field.

Many students are serious about workforce development and aspire to a second career. Master Your Drone students also include those from companies looking to integrate UAS into their day-to-day operations. The Chester Water Authority, for example, has hired Master Your Drone instructors to aid in situational awareness during drone flights. Instructors at Master Your Drone recognize their role in providing opportunities within an entirely new job market. As the CEO stated, "What we bring to the marketplace and to our students is inspiration, positivity, encouragement. We bring a future to people that are looking for something new, something different, or that are looking to pivot and venture into a new market."

Conclusion

As UAS continue to proliferate, companies like Master Your Drone that offer training are critically important to educate and provide experience to new users of UAS. Master Your Drone has reported the greatest increase in customers within the last year, even with the challenges of COVID-19. Recreational and commercial users alike can learn safe and responsible drone operation while pursuing FAA certification if desired. Companies and hobbyists are benefitting from the experience and hands-on training offered by Master Your Drone.

URBAN AIR MOBILITY AND UAS TRAFFIC MANAGEMENT CASE STUDY

The continued development of Uncrewed Aircraft Systems (UAS, or drones), means that UAS are being adapted into every facet of life, from hobbyist flyers to commercial implementations. One of the most exciting growth markets in UAS is Urban Air Mobility (UAM), considered part of the broader context of Advanced Air Mobility (AAM) which reflects the overall transformative nature of air-related technology. Per the Federal Aviation Administration (FAA), UAM envisions a safe and efficient aviation transportation system that will use highly automated aircraft to operate and transport passengers or cargo at lower altitudes within urban and suburban areas. UAM will be composed of an ecosystem that considers the evolution and safety of the aircraft, the framework for operation, and more.¹ Relatedly, unmanned aircraft system traffic management (UTM) is a “traffic management” ecosystem for uncontrolled operations that is separate from, but complementary to, the FAA’s Air Traffic Management (ATM) system.² UTM is primarily employed for beyond visual line-of-sight operations, meaning its implementation will go hand-in-hand with the adoption of UAM.

The UAM/UTM industry, while still new, is a significant piece of the larger UAS industry. This case study details the findings and insights from two of Pennsylvania’s leading businesses in the UAM/UTM industry, OneSky and Near Earth Autonomy.

UAM/UTM is One of Pennsylvania’s Most Rapidly Growing Aviation-Related Industries

Both OneSky and Near Earth Autonomy are less than 10 years old and evolved from other businesses or endeavors. OneSky, which develops airspace assessment, operations, and traffic management solutions for the aviation industry, evolved from a company that sold similar software technology to defense and intelligence companies.³ OneSky has 20 total employees, with 12 located in Pennsylvania, and anticipates that their firm will continue growing as UAS becomes more integrated into the fabric of the aviation network. As a OneSky representative stated, “UTM is the prerequisite to the safe integration of airspace. OneSky provides digital infrastructure to its operator(s) and enables additional safety... States are now realizing that the statewide implementation of this infrastructure will help the industry and their economies grow.”

¹ Federal Aviation Administration, “Urban Air Mobility and Advanced Air Mobility,” https://www.faa.gov/uas/advanced_operations/urban_air_mobility/

² Federal Aviation Administration, “Unmanned Aircraft System Traffic Management (UTM),” https://www.faa.gov/uas/research_development/traffic_management/

³ OneSky, <https://www.onesky.xyz/>

Near Earth Autonomy was founded in 2012 and has grown to nearly 100 people, with headquarters in Pittsburgh. The firm is working towards a future where autonomous flight is commonplace and safe. Their work enables a range of uncrewed aircraft to operate across multiple applications.⁴ Near Earth Autonomy has recently begun to increase the scale of its operations and has gotten traction internationally. The Near Earth Autonomy CEO noted that “there are 5,000 high-tech jobs in Pittsburgh alone [including nearly all of those at Near Earth Autonomy] and the firm is attracting businesses from Europe. If business continues to grow as it is, Near Earth Autonomy will be hiring even more people in these high-value jobs.”

New Developments Are Just On the Horizon

OneSky is optimistic that UTM, while currently in its infancy, will continue to grow along with the expansion of the UAS industry. In particular, most UAS operations are currently within visual line-of-sight but a OneSky representative noted that beyond visual line-of-sight operations are anticipated to increase as regulations change and are fully implemented. Beyond visual line-of-sight operations generally have a higher return on investment and provide more responsive, persistent, and reliable data. Further, beyond visual line-of-sight operations are able to rely more heavily on an integrated UTM system, increasing safety for all aviation users.

The Near Earth Autonomy CEO noted that Pennsylvania has a large aerospace industry and he anticipates that UAM/UTM will be a significant segment of that industry in the years to come. However, being able to test beyond visual line-of-sight operations within a drone corridor, such as the one located in Virginia, would help these operations grow even faster.

⁴ Near Earth Autonomy, <https://www.nearearth.aero/about-us>

Conclusion

UAM/UTM is an exciting advancement within the UAS industry, and two thriving businesses in this field are located in Pennsylvania. OneSky and Near Earth Autonomy provide software solutions that enable the safe integration of airspace and encourage safe and secure autonomous flight. Both firms reported that they are growing—hiring more people, expanding in their field, and bringing business into the state. With recent developments in the aviation industry, including changing regulations surrounding beyond visual line-of-sight operations, both see bright futures ahead.

UAS AND UTILITIES

CASE STUDY

Uncrewed Aircraft Systems (UAS, or drones) are revolutionizing industries across the board. The utility industry is a prime example of this advancement. Utility companies are responsible for generating, transmitting, and distributing energy. At every step of this process, infrastructure must be frequently inspected and maintained in order to distribute energy safely, efficiently, and quickly. Many utility companies have begun using drones for the inspection process, as they afford numerous benefits that cannot be achieved through traditional inspections alone. This case study details how drones have been used in the utility inspection process by one utility company, Exelon Clearsight.

Gaining Experience in an Evolving Industry

Exelon Clearsight operates for Exelon Corporation, one of the nation's largest utility providers. Exelon Clearsight is based in Pennsylvania and employs 65 staff; 40 of these employees are on the operations team and are all trained UAS pilots. Exelon Clearsight has gained immeasurable experience in UAS, whose everchanging rules and regulations can make it difficult to reliably add UAS to regular business practices. An Exelon Clearsight representative noted "Exelon Clearsight very frequently applies [for a Federal Aviation Administration (FAA) waiver or exemption for drone operations], as we need to operate in restricted airspace." The waiver process may prevent some companies from accepting certain assignments or from operating at peak efficiency. However, Exelon Clearsight has experience with the waiver process, noting that "Approximately five percent of all [our] labor time [is spent] on waivers across the company... Approximately 80 percent of Exelon Clearsight's missions include clearing restricted airspace."

Exelon Clearsight optimizes drone usage for the tasks most typical to their operations and operates only small, commercially available, FAA-standard drones. While the Exelon Clearsight representative noted that he believes the UAS industry as a whole is headed towards using larger, heavier drones, these are not useful to the company's current operations.

Drones Increase Safety and Efficiency in Utility Inspections

As with other types of inspections, utility inspections may pose a risk to the inspector. The Exelon Clearsight representative noted that while 95 percent of utility inspections are still traditionally completed (i.e., without drone assistance), he expects that in just a few years this percentage will shrink to five. This is because UAS increase not only the safety but the efficiency and accuracy of utility inspections. As the representative noted, "Traditional inspections are purely visual. An inspector may be walking along a dangerous right-of-way, or hanging out of a helicopter, or going into a confined space in order to inspect facilities. There is a huge safety and speed improvement with UAS. Drones can go into almost any environment, even if that environment would be unsafe or otherwise hazardous to humans." In order to increase these safety benefits, among other reasons, Exelon Clearsight conducts the majority of its operations in-house. A typical drone operator may not be able to operate safely around electrical infrastructure, which Exelon Clearsight pilots are specifically trained to do.

Drone inspections also increase the detail and quality of data collected when compared to traditional inspections. Drones collect data digitally from the start, whereas traditional inspections are typically handwritten and then transcribed. This digital data is more accurate, more detailed, and of higher quality. Finally, conducting inspections with drone assistance decreases the time spent on a typical task. The Exelon Clearsight representative noted "To take an example, consider inspecting distribution poles. A UAS team can inspect 100 poles in a day. A visual team can inspect 40 poles. Moreover, if the visual team were to try to inspect more poles in a day, there would be a notable quality cut."

Conclusion

Utility companies are utilizing UAS to conduct routine inspections with great success. Exelon Clearsight was founded to capitalize on the numerous advantages afforded by drone inspections. These benefits include increased accuracy, heightened safety, and a reduction in time and cost. Over time, it is estimated that utility production will become more reliable and safer not only for utility companies, but for customers as well.