ACCELERATING THE POTENTIAL OF DRONES FOR LOCAL GOVERNMEN

INTERNATIONAL BEST AND EMERGING PRACTICE REPORT

APPENDICES TO THE SUMMARY REPORT

Comhairle Cathrach Bhaile Átha Cliath
Dublin City Council

SMART DUBLIN

Our Public Service

Maynooth University
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IAA

LGMA
An Chníomhaireacht Bainistíochta Rialtais Áitiúil
Local Government Management Agency

Background

These appendices are additional resources to the International Best and Emerging Practice Summary Report. The Summary Report and Appendices are part of the "Accelerating the potential of drones for local government" project led by Dublin City Council and Smart Dublin, and co-funded by the Department of Public Expenditure and Reform (DPER) through the Public Service Innovation Fund (PSIF).

The Summary Report and Appendices can be accessed at:

https://bit.ly/3QbSiB5

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Appendix A: International drone use cases and benefits

(Expanded references for the Summary Report table 2, page 15 -18)

A.1 Public Safety

1. PUBLIC SAFETY

Fire Services Site Mapping

The use of drones has already made a large impact on how effectively a fire services team can respond to disasters or accidents, especially in terms of getting an early view of the fire site, identifying hazardous materials and plotting exit and entry points. Where drones are being used, the tactical and strategic leads (depending upon roles and responsibilities within specific organisations) can use data being streamed back from the drone in real time. This informs and strengthens their risk assessments. When using live data from an incident, tactical planning/deployment decisions can be taken on the basis of a more complete picture, instead of necessary and time-sensitive decisions being made on the basis of an incomplete picture. Drone mapping software offers the additional potential to get a real-time visual overview to instantly share intelligence with the strategic and tactical leads. This data can be shared onwards with operational teams on site, as well as partner organisations who have the setup to share this data, drastically reducing the likelihood of tactical decisions being made on the basis of old data and providing a shared situational awareness for all partners to work together more effectively. This means increased capacity for logistical coordination, more effective planning and decisions, with less risk to life, and a far greater likelihood of a positive resolution for all involved.

These operations include:

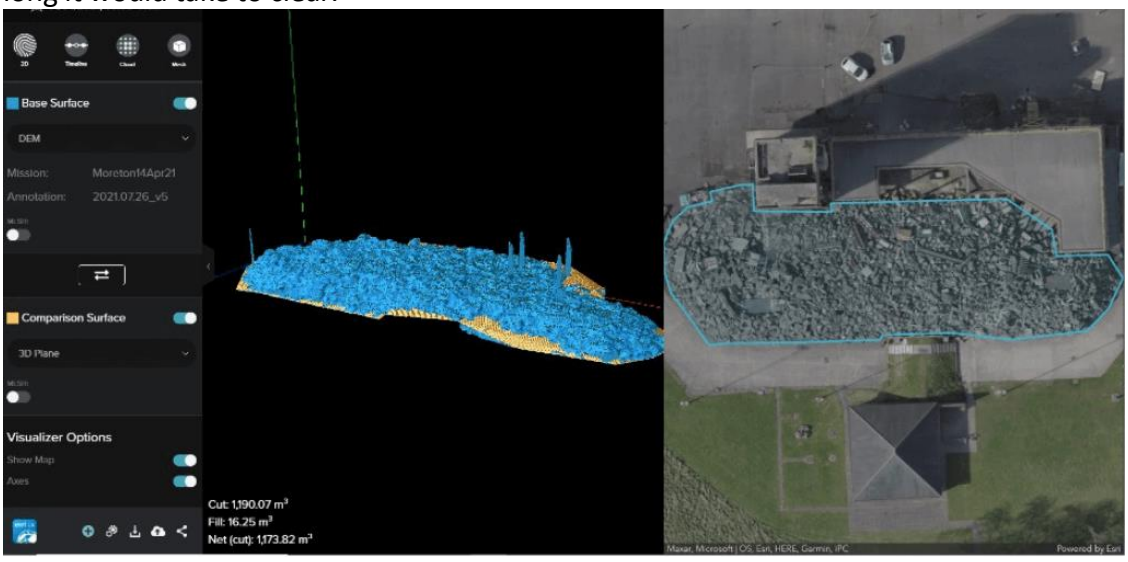
- Drones can offer an aerial perspective on a wildland fire, visualizing the spread of a fire and helping identify areas of evacuation and most urgent needs for response or water drops.
- For urban settings, drones can offer command a visual perspective on a rooftop setting or help spot civilians trapped on upper floors of tall buildings.
- For search and rescue operations, drones can cover areas at a faster rate since they are not hindered by landscape. Drones can help searchers understand the terrain they will be covering and help narrow down the area to be searched.
- In cases of large-scale traffic accidents, drones can show the scale of the event and help form possible options for rerouting traffic flow during response.
- During situations involving hazardous materials, drones can identify areas that should be avoided by responders, or to identify the most urgent needs for containment.
- Drones utilizing infrared technology can help locate survivors in low visibility or dense vegetation.
- Images and videos recorded by drones can be utilized after an incident for fire investigations, critiques, and training purposes. The information is also helpful in

understanding where additional assistance from additional organisations might be needed.

https://www.eso.com/blog/using-drones-to-fight-fire/

London Fire Brigade (LFB) - one of the world's largest firefighting and rescue organisations in the world – has been trialling Esri UK's ArcGIS software to turn DJI drone photogrammetry data into 2D orthomosaics and 3D models. These digitised assets - which can be shared quickly and easily to drive decision-making and streamline workflows - can be used to obtain deep insights, such as **conducting volume calculations following a building collapse or providing up-to-date maps to facilitate effective HazMat response**. Speaking during a joint webinar between LFB, its drone supplier heliguy™ and Esri UK, Station Officer Newman said: "Drone mapping is the future for the fire service and public safety. It can be used on live and major incidents, urban search and rescue, and for asset management. "In this day and age, firefighter safety is paramount. Combining drones and drone mapping software - and the information and the accuracy they give you - is a game changer. Drones themselves have changed the game for firefighter safety, putting the drone into an incident or location where you might have previously put a firefighter. But drone mapping is another layer of safety that can be added to incident response."

While LFB has not currently used drone mapping at a live incident, the team has conducted tests at its Moreton-in-Marsh training centre and can see its huge potential for public safety. LFB has demonstrated how drone mapping can be used for urban search and rescue missions, such as following a building collapse. Using the DJI Mavic 2 Enterprise Advanced, the team flew over the damaged structure, captured 100 images and processed the data to create this 3D model. Station Officer Newman said: "The model was created within no time at all. Such a quick turnaround is useful, especially during live incidents." This 3D model can then be used to conduct vital calculations. The below image shows how the software can calculate the volume of the debris. This provides insights such as the size and weight of the pile, and how long it would take to clear.



Station Officer Newman said that drone mapping is a great tool for HazMat incidents. Drones have already shown their worth for this type of operation - collecting vital information to keep officers away from danger. Drone mapping further enriches this process. For instance, 2D orthomasaic captures the scene of a simulated HazMat incident at LFB's test site.

The first benefit of using drone mapping is that it produces up-to-date maps - instead of relying on data from Google Maps which could be years old and no longer accurate. This drone mapping data can be quickly collected and rendered and re-edited as the incident progresses. The map can then be used to highlight key information: the area of the chemical spill, the cordon, and the entry/exit points. This information - which provides vital situational awareness - can be uploaded and shared with other agencies to help coordinate incident response.
https://www.heliguy.com/blogs/posts/public-safety-with-drones-and-gis

Drones are perfect for providing real-time data about evolving, remote or hard-to-reach emergency situations, particularly in high-risk incidents with a potentially lethal hazard (such as an environmental incident with a potentially toxic plume, nuclear incidents, or fires at a power station, or site with incendiary substances). Utilising drones in these situations reduces the risk to human life. **For example, with the ever-increasing occurrence of moorland fires in the UK, a DJI Matrice fitted with a DJI Zenmuse XT2 thermal-imaging camera can inform firefighters of pockets of peat that are still smouldering underneath areas they had previously extinguished.**
www.coptrz.com/

As units arrive on-scene, drones can provide a comprehensive picture of the initial incident. This information helps commanders determine the size of the incident, its severity, what initial resources are needed, and the overall response objectives. For example, the Conway Volunteer Fire Department in Missouri recently deployed a drone over a multiple vehicle accident on a major interstate to assess the scope of the incident and determine an effective response plan. During a large or complex incident, it may not be feasible to capture a complete 360-degree view, due to the location of the incident. Even so, drones can often help incident commanders fill in information gaps by capturing snapshots about response operations in real-time. The ability for incident commanders to know real-time conditions of the scene, along with progress of current response efforts, helps them adjust tactical decisions to meet the current situation. **In addition to providing real-time information, drones can be programmed to record operations. These recordings can be used for after-action assessments, identifying future training needs, or even to provide detailed information to local media so the community has an accurate perspective of the emergency.**
https://www.firerescue1.com/fire-products/drones/articles/how-drones-can-aid-fire-service-response-8Pnb1BlNISw6leRt/

The Kaiserslautern Military Community Fire Department's first drone was purchased as part of its hazardous materials response. During a hazmat response, the drone was set up and used in an initial entry capacity. **The drone allowed the commander to evaluate the type, size and location of the hazardous materials release. This reduced exposure times to responders and identified required mitigation techniques. The drone was added to the hazmat rescue apparatus, ensuring it was available when called for by the incident commander.**
The drone was also used as a training aid; it was deployed during training evaluations to record initial response. The recording was later reviewed in a classroom setting, where

instructors could highlight techniques, possible improvement areas and show response objectives in action.
https://www.firerescue1.com/fire-products/drones/articles/how-drones-can-aid-fire-service-response-8Pnb1BlNISw6leRt/

Hellenic Petroleum, an energy group in South East Europe, believes live and persistent aerial imagery is a critical tool to help responders act efficiently and provide situational awareness of incidents that could span large areas of real estate, such as at refineries, where fire presents not only an immediate risk to life but can also create a natural disaster and have severe financial implications. Together with the Greek national authorities, **Hellenic Petroleum simulated a major accident where a fire broke out after the crash of a tractor into a pipeline junction connecting two Hellenic Petroleum Refineries and two other oil and gas companies. With a DJI Inspire 1 tethered to an Elistair Ligh-T power station, the company had an aerial overwatch that remained airborne for the whole duration of the exercise, providing the security manager and the head of the fire department with crucial deep knowledge of the situation to conduct the operation.**
https://www.commercialuavnews.com/public-safety/four-innovative-use-cases-for-drones-in-fire-rescue

Fire Services - Integrating Drone Operations with Ground-based Assets

A regional UTM and management project to coordinate drone flights, manned aircraft operations and ground-based first responder missions has been launched In Navarra, Spain. The 'U-Space Navarra' project, promoted by the General Directorate of the Interior, brings together FuVex (a long-range drone company), UPNA, Naitec, Naturgy and Sistemas de Navarra, as well as Civil Protection and Emergency teams, the Provincial Police and Firefighters within a public-private consortium. Flights will be coordinated at the Pyrineum International Flight Center, in Lumbier, a drone test centre, "turning the Foral Community into a strategic space for testing and the implementation of this new technology applied to emergency care: rescue, fire extinguishing, traffic management, location of people or inspection of critical infrastructures," according to local authority press statement. "Drones are already a common tool in critical operations carried out by the Foral Police, Firefighters, Civil Protection and Emergencies of Navarra. To coordinate the actions of various devices, the U-Space project, led in Spain by ENAIRE, develops an automatic traffic management system in a safe and efficient way with the rest of the airspace. The first use case of this coordination operation in Navarra will consist of drones conducting inspection flights of a power line (controlled from a remote command station) in a contiguous area where Foral Police or Firefighters drones respond to an emergency. **The U-Space system would allow the line inspection drones to evacuate the emergency area in a coordinated manner with the drones of the Foral Police or Firefighters, without compromising the operation. In addition, during this summer innovative systems to search for missing persons have been put to the test and, in the coming months, we will collaborate in the implementation and deployment of the necessary software for the on-site coordination of the manned and unmanned aerial means that they intervene in emergencies outside airport spaces.**

As a next step, the public-private initiative aims to develop the first remotely controlled flights in the European Union, within the European Project RIMA (Robotics for Infrastructure Inspection and Maintenance, in Spanish, Robotics for the Inspection and Maintenance of Infrastructures)."

https://www.navarra.es/es/noticias/2021/08/31/navarra-pionera-en-el-uso-de-drones-para-seguridad-ciudadana?pageBackId=363032&back=true

In a new partnership with the French group Desautel, Fotokite will provide French firefighters with immediate access to aerial RGB and thermal points of view during emergencies. As a manufacturer of protective equipment and fire and rescue vehicles, **Desautel will integrate the Fotokite Sigma drone with its entire range of vehicles. With a single push of a button, Fotokite Sigma saves resources by launching, flying, and landing automatically with no piloting necessary**. Recognized by aviation authorities as a safer alternative to traditional tethered drone and free-flying public safety drone systems, the actively tethered drone has a 24-hour flight time and supports a dual vision camera system consisting of a 256p 30fps thermal camera and a 720p 30fps RGB camera.
https://www.commercialuavnews.com/public-safety/four-innovative-use-cases-for-drones-in-fire-rescue

Fire Services High Rise Emergency Air Support

EHang Autonumous Aerial Vehicles (AAVs) including EH216F (firefighting model), EH216 and Falcon B Series were utilized in the recent UAV fire rescue drill in Laixi City, Qingdao, in Shandong Province, China to collaborate with the local Emergency Management Bureau, Fire Rescue Brigade, Housing and Construction Bureau and other departments to **successfully complete high-rise firefighting and emergency rescue exercises with smart emergency rescue and aerial firefighting technologies**. This is the first time for EH216F to be applied by emergency fire departments in a fire drill after it has successfully completed the technical examination by the China National Fire-Fighting Equipment Quality Supervision Testing Center.

The drill replicated a high-rise fire scenario on a construction site. The Emergency Command Bureau of Laixi City quickly dispatched multiple EH216F, EH216, and EHang Falcon B Series to provide emergency air support. The dispatched aircrafts successfully completed tasks such as fire detection, aerial broadcasting, airdropping emergency firefighting supplies, breaking high-rise windows and extinguishing fires, and rescuing trapped persons among other functions as solutions to critical pain points in urban high-rise firefighting and greatly improve emergency rescue and firefighting efficiency.

This fire drill is based on the authentic lack of capabilities in local high-rise emergency rescue and firefighting forces, fully demonstrating the advantages of UAVs in high-rise rescue, such as breaking through space limitations, rapid response, remote monitoring, cluster management, multi-machine linkage, and avoiding casualties. Meanwhile, AAVs also supplements the UAV emergency rescue and firefighting force in Laixi City, Qingdao, helping to establish an efficient unified command, prompt response, and orderly coordination UAV emergency rescue and firefighting linkage mechanism. This would provide more accuracy for more effective auxiliary decision-making in handling

emergencies and improve the overall capabilities of urban emergency rescue and firefighting forces.
https://www.ehang.com/news/801.html

Fire Services Creating Firebreaks

Prescribed burns are a vital land and wildfire management tool. One form of a prescribed burn, a backfire, is deliberately initiated in front of an advancing wildfire to starve it of fuel. Setting backfires is treacherous. Success often requires working so close to the wildfire that the inferno's updraft sucks the backfire toward it.
Due to the thick smoke and cloud layers during the Marin County fire back in August, no manned aircraft could be assigned to the operation. This allowed firefighters to use drones to help them put it out.
While most firefighting operations use drones to improve situational awareness, Drone Amplified developed IGNIS, a safe and affordable fire ignition management system for drones. **By carrying a payload of ping-pong size chemical spheres injected with glycol, firefighters can use the drone to drop these spheres precisely where they want them to start a chemical reaction and generate flames.**
https://www.ctif.org/news/prevention-control-using-back-fire-combat-wildfire
https://www.commercialuavnews.com/public-safety/four-innovative-use-cases-for-drones-in-fire-rescue

Seach and Rescue (SAR) – Locating Missing Person

For SAR in a river, exposure time is critical to avoid hyperthermia, panic and drowning. In June 2021, drones employed by public safety units in both North Carolina and Ohio helped rescue missing kayakers in a span of approximately five minutes apiece. In the Ohio search, ground crews had already scanned the river banks for hours to no avail. Night closed in, making the search even more difficult. Once drones with thermal sensors and spotlights took over, a missing father and son were quickly located. Similarly, in North Carolina, aerial thermal imagery at nightfall enabled a rescue within minutes.
Opportunity Spotlight: Drones are Critical to Infrastructure - Inside Unmanned Systems

Improving Flood Risk Maps

Shellharbour City Council in Australia has enriched its Macquarie Rivulet Floodplain Risk Management Study by using new drone technology. **Drone operator Measure Australia captured high resolution LiDAR, enabling accurate mapping of the Macquarie Rivulet floodplain to inform a critical update to the flood modelling undertaken in the catchment**.
Responsible for flood strategy and actions, Council's floodplain management team acts to mitigate flood impacts on the community and environment. They take information from diverse sources encompassing satellite, river gauges, community reports and even the Wodi Wodi tribe's oral history. However, review of the Macquarie Rivulet flood study (2017) revealed data gaps, including areas that had changed substantially since prior surveys and some areas too challenging to have ever been surveyed. This included areas too remote and heavily vegetated to safely deploy surveyors to – others in difficult topographical areas were missed by fixed-wing (plane) LiDAR surveys. Council's manager of

floodplain and transport Adam De Clouett investigated drone data collection and found that Measure Australia would deliver the geographical coverage and high technical specification desired for this project. Measure Australia conducted a series of flights using the Riegl MiniVux 2, which can scan 1 million points per second, with density 180 points per square metre delivering very rich and accurate data.
https://www.measureaustralia.com.au/casestudies/shellharbour-city-council

A.2 Health and Environment

2. HEALTH AND ENVIRONMENT

Defibrillator Delivery (AEDs)

In a clinical trial carried out by the Department of Medicine, Centre for Resuscitation Science, Karolinska Institutet, Stockholm, Sweden, three AED-equipped drones were placed within controlled airspace in Sweden, covering approximately 80 000 inhabitants (125 km^2). Early defibrillation is critical for the chance of survival in out-of-hospital cardiac arrest (OHCA). Drones, used to deliver automated external defibrillators (AEDs), may shorten time to defibrillation, but this has never been evaluated in real-life emergencies. The aim of this study was to investigate the feasibility of AED delivery by drones in real-life cases of OHCA. Drones were integrated in the emergency medical services for automated deployment in beyond-visual-line-of-sight flights: (i) test flights from 1 June to 30 September 2020 and (ii) consecutive real-life suspected OHCAs. Primary outcome was the proportion of successful AED deliveries when drones were dispatched in cases of suspected OHCA. Among secondary outcomes was the proportion of cases where AED drones arrived prior to ambulance and time benefit vs. ambulance. Totally, 14 cases were eligible for dispatch during the study period in which AED drones took off in 12 alerts to suspected OHCA, with a median distance to location of 3.1 km [interquartile range (IQR) 2.8–3.4). AED delivery was feasible within 9 m (IQR 7.5–10.5) from the victim location and successful in 11 alerts (92%). AED drones arrived prior to ambulances in 64%, with a median time benefit of 01:52 min (IQR 01:35–04:54) when drone arrived first. In an additional 61 test flights, the AED delivery success rate was 90% (55/61).
In this pilot study, we have shown that AEDs can be carried by drones to real-life cases of OHCA with a successful AED delivery rate of 92%. There was a time benefit as compared to emergency medical services in cases where the drone arrived first. However, further improvements are needed to increase dispatch rate and time benefits.
https://academic.oup.com/eurheartj/article/43/15/1478/6358076#292213251

Delivering Medical Supplies

The coronavirus has had a devastating impact across the world. As scientists and medical professionals look for vaccines and treatments, the UAV community is helping to keep people safe. The Solent Transport partnership includes the Hampshire County Council,

Portsmouth City Council, Southampton City Council, and the Isle of Wight Council, UK. The partnership has worked with the University of Southampton to test drones delivering medical supplies across the strait. This is a pre-cursor to the Future Mobility Zones (FTZ) initiative that is due to start. This 3-year, cross-organizational, multi-million pound regulation, infrastructure and technology project will see the Solent area become the UK's first full functional "UTM," pioneering routine Beyond Visual Line-of-Sight (BVLOS) drone operations. The trial, a first of its kind, used Windracers ULTRA UAV to transport medical supplies to COVID patients on the Isla of Wight, the United Kingdom's second-most populous island. **Researchers and government officials hope to increase efficiency, decrease the transportation time for medical supplies in the region, and reduce costs.**
https://consortiq.com/4-municipalities-advanced-with-drone-technology/

Atrium Health Wake Forest Baptist and UPS have started delivering COVID-19 vaccine by drone at the health care system's medical complex in Winston-Salem, North Carolina, an operation they described as the first such vaccine drone delivery program in the U.S. Announced on Aug. 24, the program transports vaccines using a UPS-operated Matternet M2 quadcopter fitted with a special cargo box from the medical center to outlying family medicine practices, a distance of less than a mile that briefly passes over the Salem Parkway. The vaccine initiative expands on a drone delivery service started by Wake Forest Baptist Health and the UPS Flight Forward subsidiary in July 2020. Atrium Health and Wake Forest Baptist Health merged last October. The drone-delivery service has transported lab samples, specialty infusion fluids and individually compounded medications at the medical complex since its inception. On Dec. 14, 2020, Atrium Health Wake Forest Baptist became one of the first health care organizations to receive supplies of the temperature-sensitive Pfizer-BioNTech COVID-19 vaccine, which can now be distributed by drone as with the other available vaccines. When transporting COVID-19 vaccines, the Matternet M2 is fitted with a cargo box that contains Cold Chain Technologies' PCM Gel solution, a packaging mixture that maintains the vaccine temperature at 2 to 8C (35-46F), and a temperature-monitoring device. The customized cold-chain packaging complies with Centers for Disease Control and Prevention guidelines on the handling, storage and transportation of COVID-19 vaccines, the health care system said.
"Distributing and protecting the integrity of the COVID-19 vaccine is our top priority and we've successfully completed multiple test flights to ensure that the vaccine remains at the appropriate temperature throughout transit," said Jennifer Tryon, Atrium Health Wake Forest Baptist chief pharmacy officer. "The ability to use a temperature monitoring device for our COVID-19 vaccine drone delivery program also opens the door for us to transport additional items which require maintenance of the cold chain."
Aviation Week Advanced Air Mobility Report September 2021.

The first Harmony-H2020 demonstration in the Municipality of Trikala, Greece, took place on September 2021. **The drone delivery of medicines in Trikala, Greece will connect the city centre to the pharmacies in the surrounding rural areas, serving primarily the urgent needs of elderly and other vulnerable social groups with limited access to mobility services.**
In this first test flight, the drone transported emergency medicines (e.g. adrenaline), which landed at the pharmacy of the settlement of Leptokarya in the Municipality of Trikala, from

where the pharmacist received them. The ultimate goal is to complete the program by sending drugs to remote areas. The experience of Trikala will be transferred to the EU.
https://trikalacity.gr/sta-trikala-i-proti-paneyropaiki-ptisi-gia-paradosi-farmakon-me-drones/

Urban drone delivery company Matternet has announced a city-wide drone delivery network for the rapid transport of medical goods in Abu Dhabi, in collaboration with the Abu Dhabi Department of Health (DoH) and UAE logistics company SkyGo. Matternet will operate its technology under SkyGo's license for BVLOS drone delivery, and transport urgent, high-value goods such as COVID-19 vaccines, blood, and lab samples across the Abu Dhabi's health system. Notably, Matternet became the first drone company in the US to start transporting the Pfizer-BioNTech COVID-19 vaccine by drone.
The companies plan to install 40 droneports in Abu Dhabi by the end of the first year of operation. A drone transportation network at this scale not only will make healthcare more efficient and improve patient outcomes, but also will reduce the number of delivery vehicles on Abu Dhabi's roads, alleviating congestion, improving air quality, and lowering the city's carbon footprint.
The Abu Dhabi city network will enable faster turnaround time of diagnostic and pathological samples, more reliable shipment of time-critical supplies, waste reduction from inventory centralization, and consolidation of distributed facilities (e.g. labs and pharmacies) to lower overhead.
The service is expected to grow to a 24/7 operation.
www.matternet.com

Sanitising Urban Areas

The city of Dubai has been a significant supporter of drone technology. From drones for the police force to UAV taxis carrying humans, the city has embraced the UAV industry and continues to do so in the fight against COVID. With a population of over 3.3 million, Dubai faces severe challenges from the virus. Public spaces are potential breed grounds for COVID and of great concern to city officials. **Dubai is employing drones to sanitize large areas of the metropolis. Drones designed initially for spraying pesticides in agriculture are now being repurposed for the task. The municipality is sterilizing 129 sites across the city and 23 public areas. The operation is part of a national sterilization program aimed at curbing the spread of COVID.**
https://consortiq.com/4-municipalities-advanced-with-drone-technology/

Delivering Transplant Organs

A group of research teams in Italy are set to begin trials deploying drones to transport human kidneys, reports *dronedj.com.* These are the first tests of its kind in Europe. The trial flights are to begin in September 2021 in Turin, where drones will be used to transport kidneys that would usually be rushed by road ambulances, often through congested traffic.
These demonstrations hope to replicate the successful U.S tests conducted in Maryland during 2019, when a drone successfully delivered a kidney that surgeons immediately transplanted to a waiting patient. The Italian research teams aim to replicate a similar result.

Antonio Amoroso, Coordinator of Turin's Piedmont Region's Transplantation Centre, commented, "Transporting organs is an essential part of the transplant process (and) carrying them on ambulances means dealing with traffic and time constraints." He continued, "We need to find new ways for delivering organs to increase safety levels for our patients as well as the quality of our services." Meanwhile, earlier this year, Minnesota, U.S., conducted a trial drone flight to deliver a pancreas. Again, the first of its kind. As with the Maryland tests, biopsies of the organ showed no damage caused by UAV transport and as like the 2019 kidney transplant flight, registered fewer and lower-level vibrations potentially effecting the tissue in drone transportation than via road options.
https://www.youtube.com/watch?v=91RFi9P0wvw

Pollution Control

Cargo ships bring the things people want and need to our ports. But they also bring air pollution. And when they burn cheap, sludgy fuel, their emissions include dangerously high levels of sulfur and nitrogen oxides, which along with particulate matter, form a toxic mix that harms respiratory and circulatory health. But, according to a new report produced by UCLA environmental science students, technology may come to the rescue. The report notes specifically that powerful sensors mounted on industrial-scale drones that can fly in a ship's exhaust plume to detect whether the fuel being burned is within legal limits. The report was part of the UCLA Institute of the Environment and Sustainability senior practicum, in which small teams of students, under the guidance of faculty advisers, work on a yearlong project on behalf of clients to solve real-world problems. This team partnered with the ADEPT Group, Inc., an environmentally focused tech company, to find out how drone-enhanced enforcement of the California Sulfur Rule could affect public health. They modelled outcomes for two scenarios: one in which ships were cheating at a 10% rate — a rate similar to the documented incidence of violations in European waters — and a "clean" scenario that assumed effective enforcement and full compliance. **Estimates are that 20 to 25 percent of ships are in violation of current standards, according to ADEPT. Enhanced enforcement with aerial monitoring could avoid 55 deaths due to air pollution each year in the port communities of Wilmington, Carson, West Long Beach and San Pedro, the student researchers projected. In addition to saving lives, there would also be about $600 million savings in medical costs.** According to these initial findings, each year better enforcement would prevent approximately 2,600 cases of asthma and 1,200 cases of asthma morbidity, or acute attacks requiring emergency room visits or hospitalization.
https://newsroom.ucla.edu/stories/drone-monitoring-of-ship-emissions-could-save-lives-protect-health

Air pollution generated by industry, traffic and house heating is a big challenge of larger cities that effect life quality. The aviation industry corporation of China is trying to control the worsening pollution by Para-foil drone. This specific drone is normally equipped with a paragliding wing that carries chemicals and release chemicals in order to reduce the amount of fine particles matter (FM 2.5), that reduce visibility and causes the air to appear hazy and harmful to people health as well. A group of designers in Hong Kong aim to develop a "parasitic drone" that perch on neon billboards and suck up pollution to yield plants and produce fuel. "Hilpert and collaborators at the School of Engineering and the Lamont-Doherty Earth Observatory are building a research platform for a quadcopter

drone to measure pollution spewing from industrial smokestacks. Once complete, the "drone" will ascend up to 400 feet to collect samples for later analysis in a lab".
https://www.researchgate.net/profile/Muhammad-Khan-716/publication/316846331_Drones_for_Good_in_Smart_CitiesA_Review/links/5a27c404aca2727dd883c881/Drones-for-Good-in-Smart-CitiesA-Review.pdf

Monitoring Critical Infrastracture

Four million miles of roadways, 600,000 bridges and 350 tunnels. Two million one-hundred thousand farms. More than 4,000 U.S. public safety agencies fielding drone programs. Damage estimates for insurance companies and safeguarding against school shooters. UAS are an intrinsic part of supporting and protecting critical infrastructure in America. Take, for example, the unmanned systems that came to the rescue when an aging dam in Florida, the only barrier holding back lead and nickel-poisoned water from flooding a nearby town, required inspection. Sending divers into toxic water was not an option. Draining the dam would have been prohibitively expensive**. Triad Drones, a Safety Harbor, Florida-based company making waves in the dam sector, used its unique unmanned and networked air, ground and subsurface vehicles, with multibeam sonar, to provide predictive structural integrity and volume analysis**. This is one of hundreds of similar drones-in-infrastructure stories increasingly happening across the country on a daily basis.
Triad Drones CEO Walter Lappert explained his modus operandi for dam inspection: "We take 3D models of the entire environment. Our ground-based lasers take images of the bare earth, to help predict where water is going to flow. Underwater, we use sonar. Our drones use LiDAR to create a model, similar to the sonar data, from the air. We register common ground control points and tie all of these models together."
https://insideunmannedsystems.com/opportunity-spotlight-drones-are-critical-to-infrastructure/

Education facilities, especially, use drones routinely, including for infrastructure purposes. Schools also use drones to protect students.
Arkansas-based MAAS (Making Aerial Acquisition Simple) generates 3D maps of local schools for responders to have on file in the event of an emergency. For husband-and-wife owners Mitch and Andi-Bandy Smith, this task is close to home. Twenty-five years ago, Andi's son was onsite during a tragic school shooting. "Had there been drone and thermal technology they could have launched, or even an accurate map of the facility, they would have found the shooters much sooner and saved more lives," she noted. "It's important for local responders to have a 3D map of schools at the ready, to be prepared for any future situations."
To support drone applications in infrastructure and beyond, U.S. colleges are offering wide-ranging R&D drone programs, from monitoring archeological digs to conducting traffic studies to taking aerial photos to promote their campuses. Several colleges, and even some high schools, offer drone-specific degrees and curricula. "This gives [students] an advantage in the job market," said Taylor Albrecht, President of Central Colorado Unmanned Aerial Systems.
https://insideunmannedsystems.com/opportunity-spotlight-drones-are-critical-to-infrastructure/

The U.S. has 153,000 water systems that supply more than 80% of the population with safe drinking water, and 16,000 publicly owned wastewater treatment systems that treat and sanitize 75% of the population's sewerage.

Drones can survey water towers, providing critical information for construction, maintenance and operations. Halff Associates manager Bill Swope said his team recently flew two water treatment plants in Tyler, Texas, for a construction design job. It combined aerial, mobile and terrestrial data and crunched it using 3D modelling. This same methodology is used to inspect for corrosion and analyze pavement at the plants.

DroneUp's sales director Rese Cleaver summed up the value proposition for this kind of infrastructure work. "Our pilots collect data that we provide to assessors for close-up visual survey and inspection requirements of water towers. This increases safety by eliminating fall hazards. It is cheaper, as assessors now have less equipment to maintain. Finally, it's more efficient—by eliminating the need for assessors to travel from site to site, they can do more surveys per day."

It's also safer, she noted. To manually inspect these towers requires assessors to use either a bucket truck or to hang out of a helicopter. The Occupational Safety and Health Administration (OSHA) ranked a lack of fall protection as the top safety violation in 2020. "Most falls occur at height," Cleaver said. "We eliminate this issue."

Jake Lahmann, quality and UAS manager at Valmont Industries, a global leader of engineered products and services for infrastructure, summed up the value of UAS for critical infrastructure. "Removing manual high-altitude operations and heavy ground vehicles reduces the risk of potentially serious accidents. The benefits of using drones for inspections are patently obvious in terms of risk and safety."

https://insideunmannedsystems.com/opportunity-spotlight-drones-are-critical-to-infrastructure/

A.3 Planning and Development

3. PLANNING AND DEVELOPMENT

Site Inspections and Enforcement

In October 2021 the New York State Thruway Authority announced it will launch a pilot program using drones in partnership with New York based nonprofit NUAIR. The initiative, which is at no cost to the Authority, has the potential to increase efficiency and improve safety while lowering costs for inspections of bridges, culverts, and pavement, along with mapping, surveying and countless other uses.

"Using drone technology to inspect bridges, overpasses and infrastructure along our entire system is an imaginable game-changer," Thruway Authority Executive Director Matthew J. Driscoll said. "Drones can provide views of hard-to-reach locations quickly and safely. This pilot program aligns with the Thruway's vision of maximizing technological innovation and continuing to improve infrastructure for the future."

If the program is deemed a success following rigorous field testing and detailed evaluation, the Authority envisions expanding the role of drones to assist with mapping and surveying the 570-mile superhighway system, cataloguing Thruway inventory and infrastructure, documenting damage and repairs, along with supporting general maintenance activities.
Presently, bridge inspection primarily depends on visual and hands-on techniques to assess the condition of the structure. That often means relying on different types of equipment, ranging from ladders and scaffolding to man-lifts and under-bridge inspection vehicles, and even binoculars.
According to the Federal Highway Administration, drones can potentially be used to look at bridge components that are difficult to see, providing inspectors with information to determine if additional inspection is needed. Drones can additionally improve the bridge inspection process in several ways:

- **Improving safety for inspectors**
- **Fewer lane closures for motorists reducing traffic impacts**
- **Lowering overall inspection costs**
- **Providing digital images and video**

NYS Thruway Press Release (10-4-2021)

The use of drones for any inspection that doesn't require physical interaction can enable organisations to manage working at height at much reduced risk. Incorporating them into business as usual would do much to keep many feet on the ground. On average, a site visit from a drones services supplier would cost around £300-£500+VAT depending on how long the inspection takes. MEWP/Cherry Picker hire would be far more than that and may not be practical in all cases dependent on the ground conditions – it can also take longer to get into position to carry out the inspection. The same is true for scaffolding, which can be extremely costly and disruptive, with long waiting times while it is erected and then disassembled. A drone can be in and out, carrying out the task in minutes**. A recent case study we carried out with a housing association for a routine roof inspection saved them £8,500 on scaffolding costs, lessened the disruption for the resident and revealed other problems that would have also cost more to fix in the medium term**. A true win-win.
Zoom cameras can hone in on specific areas for a more close-up view (Drone Evolution regularly inspect with 30x optical zoom cameras). Many clients enjoy having drone footage and photos on a regular basis as they can see progress very quickly. Missions can be fixed, meaning that photos can be taken from the same spot, every time, providing a time lapse effect. The drone can create a "digital twin" using 3D modelling which can be compared to plans and updated regularly to create a 4D model. Drones are very good at carrying out Health and Safety dip checks – fly the drone unannounced over the site and you'll soon spot who's not got the proper PPE, who's not social distancing and so on. The drone can assess volume of earthworks stockpiles. By carrying out a photogrammetry flight, the software can assess volumes which can be matched against the invoices removal companies are sending to a builder. Some drone software has an "overlay" feature, where plans can be matched to reality prior to sections of work being carried out. In the US, a large building firm carried out such a flight prior to a concrete pour – this identified a layout error. That one flight saved them between $10,000 and $12,000.
https://iosh.com/media/9233/south-wales-branch-iosh-drone-evolution-overview-january-2021.pdf

Wealden District Council in East Sussex recently revealed that it uses drones to assess planning applications and enforcement breaches. North West Leicestershire District Council is among the other authorities using drones to identify planning permission breaches. So should all planning teams be taking to the skies? According to Wealden Council's Unmanned Aerial Vehicles (UAVs) Policy, **drones are used in development management for "larger-scale site inspections" and to "aid officers and elected members when making decisions". For enforcement purposes, drones "provide a clear record of both the operational development and use of a site".** According to the policy, drones can "greatly reduce the risk to staff when dealing with confrontational individuals" and are also seen as a way to investigate potentially vexatious complaints while "removing any unnecessary stress caused by multiple enforcement visits". A Wealden Council spokeswoman outlines some of the steps the local authority takes to remain within the law. In enforcement cases, "permission to fly the drone is sought from the adjoining landowner," she said. Similarly, when using drones for development management, "we only ever use drones to scope out a site with full permission of the landowner submitting the application," she added. Euan Mills, urban futures team lead at the government-backed Future Cities Catapult, sees plenty of potential for councils to use drones. "The reality is, in planning today, we spend so much time and resources doing very repetitive and resource- intensive tasks," he said. Instead, drones might allow planners to focus their efforts on work best carried out by humans, he added. "Given the context of falling budgets we can relocate a lot of resources to much more high-value tasks."

According to Mills, planning data collected by drones can offer value not just to enforcement officers but to their strategic planning colleagues and other local authority departments such as conservation, education and ecology. However, he added that councils should ensure that they retain ownership of any data collected. "I'd much rather a democratically legitimate organisation collects and owns that data than the private sector" he said.

https://www.planningresource.co.uk/article/1583984/why-council-added-drones-its-planning-toolkit

During a six month trial period starting in September 2020, drone were supplied and operated by a specialist team from Thurrock Council who will carry out aerial drone flights, on behalf of Basildon Council's own planning enforcement team, for the purpose of investigating possible breaches of planning regulations and permissions. All drone flights are risk assessed and follow strict operations and manual procedures, which have been approved as safe by the Civil Aviation Authority (CAA). Thurrock Council who will supply aerial drone services during the trial period, use qualified unmanned aerial systems and competent remote pilots (RP) to fly drones. Each RP has passed theory and practical assessments with an organisation approved by the CAA.

The RP has overall responsibility for making sure every flight takes place within the law and its amendments. The RP and a team of airspace observers will make sure that all drone recordings are stored securely. Any recording that is not relevant to the purpose of the flight will be securely destroyed. The Information Commissioner's Office is the regulatory authority for Data Protection matters. A Data Protection Impact Assessment is in place which sets rules for how the UAS, RP and airspace observer crew must work.

https://www.basildon.gov.uk/article/8208/Planning-enforcement-Trial-use-of-aerial-drones

In 2018, the UK's Oxford Direct Services (ODS) the service delivery and commercial arm of Oxford City Council, announced that it was to start providing drone-based services to include roof and building surveying, land mapping, aerial photography and filming. Initially, ODS will focus on surveying the roofs of 7,800 properties it maintains on behalf of Oxford City Council.

"The use of drones will save time, drive down costs and reduce the health and safety challenges typically encountered with this type of work," according to ODS. "Commercial surveying, mapping, aerial photography and filming will be competitively priced consistent with each customer's specific requirements."

Ben Strang, ODS' project leader of drone services, said**:** "I was a felt roofer for 15 years. If you're working on low to high rise housing blocks to identify, for example, pest entry points or find roof leaks, putting up scaffolding is at best a very hit and miss process. You erect the scaffolding where you think the source of the issue lies but if it's not there you then waste time and money moving the scaffolding tower. Using a drone resolves this and helps us pinpoint exactly where we need to work so that we can do first-time fixes and enhance efficiency…"

All drone operators need the permission of the individual landowner to fly over their land. In the Oxford area, drone services can be delivered quickly as ODS is already authorised by the Council to do this.

Simon Howick, Oxford Direct Services' managing director, says: "Hiring a drone firm to survey a roof costs between UKP300-1000, with scaffolding also expensive and cumbersome. It made total sense to invest in the drone equipment, flight training and licensing and add this skillset to our portfolio. It will pay for itself within a year, we'll save money for our main customer – Oxford City Council – with drones becoming an additional revenue stream given we can now offer local businesses and residents surveying, mapping, photography and filming services."

https://www.oxford.gov.uk/news/article/859/game_of_drones_ods_launches_commercial_drone_services_in_oxford)

Construction and Development of Local Government Buildings

Drones can be used on construction sites for a range of tasks. These include:

- **Initial Site Survey/Measurements:** Evaluate large worksites and provide detailed, precise data for architects and contractors before stepping foot on site. This gives businesses the competitive edge from as early as the bidding process.
- **Construction Mapping/Modelling:** Drone data can be converted into detailed maps and 3D models to help with project tracking and accurate measuring of distances, surfaces, elevations, and volumes.
- **Progress Monitoring:** Access real-time aerial data to understand what is happening on site. This is ideal for progress tracking and spotting mistakes early before they become too costly.
- **Inspection:** Inspect roofs or building façades, and collect a wealth of information with zoom or thermal cameras. Drones remove the danger of manual data collection and are a far more efficient way of collecting this information.

- **Security/Maintenance:** Drone imagery can highlight any on-site issues, such as a damaged section of perimeter fence. A drone with a thermal camera can spot issues such as an over-heating tank, which could be missed with the naked eye.
- **Access hard-to-reach areas:** Drones remove the need for staff on-the-ground to clamber over potentially dangerous stockpiles, venture into hard-to-reach areas, or clamber up scaffolding. This improves job-site safety.

Cost savings: Real-time drone data yielded 75% cost savings for Chasco Constructors on a USD29 million project. Efficiency gains: "Using drones, we can take weeks out of the schedule" – Brasfield and Gorrie. Quality data: One survey showed 56% of people use drones in construction for improved data quality. Reduced risk: "Drone help with safety, taking people out of dangerous situations" – Balfour Beatty.
https://www.heliguy.com/pages/drones-for-construction

A.4 Transport and Logistics

4 . TRANSPORT AND LOGISTICS

Drones Used in Road Maintenance Monitoring

"An American Association of State Highway and Transportation Official survey estimated approximately USD3,400 in savings per drone inspection as compared to manual examination. Manual inspections take two people eight hours to complete; a drone equivalent takes those same two people only one hour….Beau Taylor, the Geohazards Program UAS Lead for the Colorado Department of Transportation (CDOT), uses drones to prevent and mitigate geologic hazard impacts, including landslides, rockslides and sinkholes, on the state's highways. They play a valuable role: CDOT maintains, repairs and plows more than 23,000 total lane miles of highway, keeps more than 35 mountain passes open year-round and monitors 278 avalanche paths annually. Taylor and his team proactively use drones for change detection, taking a series of images and creating heat maps to see what geologic changes may be occurring. This can allow them to institute prevention measures before disaster strikes. After an incident, they use 3D modelling software to plot where they can place debris flow barriers and other mitigation measures. Taylor recalled an incident in the summer of 2020 at Hanging Lake Tunnel, which allows vehicles through the southern wall of Glenwood Canyon. "Our program went out in response to the post-wildfire emergency for assessment. CDOT Region 3's drones' broad area view, combined with 3D modelling software, helped us determine where to immediately place temporary berms at the facility, to allow us to install more time-consuming mitigation measures later, while maintaining safety. This helped keep our roads open."
https://insideunmannedsystems.com/opportunity-spotlight-drones-are-critical-to-infrastructure/

Improving Traffic Surveillance

Real-time traffic monitoring and analysis is also a potential application in which drones can replace intensive labor and complicated observational infrastructure. Traffic monitoring via drone presents new perspective which could help in optimizing road traffic systems by overcoming the limitations of traditional monitoring methods because of its mobility and capability to cover large area. **Also, due to the increasing traffic volume in cities requires state-of-the-art intelligent traffic monitoring system by providing accurate information about traffic flow and road accidents to reduce traffic congestion.** COWI, which is a Danish consulting engineering company is among the first to use drone technology for monitoring and analyzing of traffic flow in Denmark. Roads and Transport Authority (Dubai) also decided to deploy drones for traffic monitoring and road accidents in Dubai city during the second quarter of 2017. In Lyon France, a company named "Elistair Tethered" offers a real-time traffic flow at rush hours by using "DataFromSky" traffic analyzer to process information about different types of vehicles.

https://www.researchgate.net/profile/Muhammad-Khan-716/publication/316846331_Drones_for_Good_in_Smart_CitiesA_Review/links/5a27c404aca2727dd883c881/Drones-for-Good-in-Smart-CitiesA-Review.pdf

The Direccion General de Trafico (DGT) is initially deploying over 40 surveillance drones across Spain as part of a trial to use drones to look for traffic violations. **The drones currently used by the Guardia Civile are equipped with powerful cameras capable of viewing the number plate from a long distance away as well as easily spotting minor traffic infractions such as speeding, not wearing a seatbelt, or tailgating.** The DGT has trained more than 35 drone and 60 camera operators to carry out this monitoring. Depending on the type of craft, one operator can carry out both functions at the same time. The most popular drone used by the DGT is the Thyra V109 that comes fitted with an automatic vehicle tracking feature. It operates at an altitude of 120 metres, making it virtually undetectable while on the road, and can fly a top speed of 80 kilometres per hour to keep up with speedsters.

https://uk.motor1.com/news/528208/spain-deploys-drones-traffic-violations/

Drones in Port

Drones are playing an increasingly important role in coordinating safety within the complex port environment. That is the reason why Port of Antwerp carried out unique trials involving a 'fixed-wing' drone . The unmanned aircraft offers the port authorities an unprecedented view of the entire port, flying at high altitude and having powerful cameras on board. The Sabca drone was used to provide images of realistic incident scenarios. The trials are intended to provide an insight into the possibilities this unmanned aerial systems can provide as a tool to assist the port authority and to make collaboration with the safety and security services more efficient. A 'fixed-wing' drone can fly around for more than eight hours and take pictures with a very powerful camera (30x zoom) from a height of 280 metres. In collaboration with Waasland Emergency Assistance Zone, the Antwerp Fire Brigade Zone and Port of Antwerp's technology partner, Sabca, Port of Antwerp tested out various use cases. **The images recorded by the unmanned aircraft of four realistic emergency situations (a container fire, the rescue of a person in distress on top of a windmill, the rescue of a drowning person and the rescue of a man overboard),**

will provide an insight into the possibilities of using unmanned aircraft of that sort within the port environment. In the future, Port of Antwerp intends to maximise the assistance provided to the Harbour Safety & Security (HSS) service and its safety partners through the use of drones. The types of tasks that can be performed include inspecting infrastructure, surveillance and monitoring, incident management, berth management and the detection of oil spills or floating waste.
https://www.sabca.be/node/505

Drone Deliveries of Non-Medical Items and Post

In July 2021 the North Carolina Department of Transportation (NCDOT) in partnership with the Dept. Ferry Division and drone company, Volansi, successfully completed two trial flights delivering goods from Hatteras to Ocracoke Island. This remote island has proven difficult to transport vital supplies to, especially during challenging weather conditions, but the recent drone trials offer another way. To simulate a real post-storm emergency delivery operation, both flights carried small payloads. The first delivered a small survival kit, space blankets and a chocolate muffin to Ocracoke, while the second delivered bottles of water."
https://www.youtube.com/watch?v=v4vx7reXUbM

Japan's national postal service, Japan Post, is joining forces with Autonomous Control Systems Laboratory (ACSL), a domestic drone manufacturer, to start delivering mail by air, no later than 2023. **Japan Post Group believe such a delivery system will be especially useful for mountainous areas and remote islands. ACSL is a Tokyo-based drone manufacturing company that develops and implements industrial drones, which is fortunate for the postal service when the country's aging population has made it difficult to hire workers. The company hopes the use of delivery drones will help alleviate this problem**. The project team involved is presently working out the air traffic controls that enables drones to fly uninterrupted with plans for the system to be fully functional by no later than 2023.
https://postandparcel.info/138625/news/e-commerce/japan-post-to-deliver-mail-by-drone-by-2023/#:~:text=Japan%20Post%20is%20joining%20forces,start%20delivering%20mail%20by%20air.&text=Japan%20Post%20Group%20announced%20its,areas%20and%20in%20remote%20islands

The UK's Royal Mail is to deploy drones to deliver letters and parcels to more remote areas of Britain. Royal Mail has partnered with a consortium of established UK drone companies including DronePrep and Skyports alongside tech firm what3words. This is the first step of a series of trials that focuses on "engaging with the community to explore the viability of using drones to deliver to rural communities on the Isle of Mull." Drone company, Skyports, is already in place, presently deploying its craft to assist NHS Scotland with the response to Covid-19. After letters and small parcels arrive at the local sorting office, the "local postie" will then employ drone delivery to reach the intended location rapidly and safely. Residents on the Isle of Mull are being invited to partner in these trials by using the DronePrep platform to assess the viability of their property for delivery. Tom Nunn, local postie for Isle of Mull, adds, "This is a fantastic trial! **Some of the properties on the island include a thirty-minute walk to the front door so the use of drones will be a huge help."**
https://www.youtube.com/watch?v=2OqRFI4B5a8

A.5 Energy

Monitoring Energy Storage and Transmission Systems

Including both fossil and renewable fuels, the 80% private-owned energy sector is also massive. The electricity segment alone includes more than 6,413 power plants. Energy companies commonly use drones for GIS data collection. Bill Swope, geospatial and survey business development manager for Halff Associates, Inc. in Richardson, Texas, leads the company's drone team in inspecting energy, transportation and water sector facilities. Oil and gas companies traditionally gathered data from the ground; his team collects geospatial data using drones for aerial shots and combines that data with mobile LiDAR from sensors on vehicles and terrestrial scans from a tripod.

"Drones can provide a lot more data for a lot less time," Swope explained. "They help us to deliver projects under budget and ahead of schedule for our clients." **By way of example, two years ago, during an oil and gas job, Halff used drones and other data collection sources to rack up 75% in time savings, shaving total costs by 30%. The company's oil and gas work has grown to the tune of about $25 million annually.**

https://insideunmannedsystems.com/opportunity-spotlight-drones-are-critical-to-infrastructure/

One example of drone application in the Energy sector is gas flares (flare stacks) in the oil & gas industry. Companies such as Rectrix in the UK, or Terra Drone based in Tokyo, Japan carry out inspections of flare stacks that burn at over 900°C. Other cases of drone application in the energy sector include surveying of powerlines and wind turbines, which companies like Aeromedia and Sulzer Shmid carry out. **By using a drone instead of a person, the inspector is not placed in dangerous situations, and the flare/powerline/turbine that is being inspected usually does not have to be shut down to guarantee human safety, which means it continues to operate and generate revenue**.

https://droneii.com/237-ways-drone-applications-revolutionize-business

Appendix B: Global examples of different classes of local authority drone programmes

(Expanded references for the Summary Report, page 12 -13)

B.1 Class One Programmes

Strategic programmes in which local authorities are the prime movers in developing a drone/UAM eco-system for their communities *(please note, not all of these programmes as sponsored by local authorities, but they all have relevance to local authority operations):*

Toulouse Métropole France	Developing a drone integration programme the sustainable integration of air mobility in its territories.
Kista Science City AB Sweden	A drone/UAM roadmap for Stockholm.
Haninge, Sweden	Search and rescue drone operations by an NGO with more than 50 drones.
Oxford, UK	Oxford Direct Services (ODS), the service delivery and commercial arm of Oxford City Council providing drone-based services to include roof and building surveying, land mapping, aerial photography and filming.
Antwerp Port Belgium	Development of a drone ecosystem supported by a Unifly UTM system.
Rome, Italy	Local authority multi-agency team with more than 40 drones for surveillance, incident management, traffic control.
Madrid, Spain	Industry team working on behalf of the local authority for crisis management, surveillance.
South Moravia, Czech Republic	Czech Fire Rescue Services had combined DJI's drone technology with aerial mapping GINA software.
Johannesburg, South Africa	NGO with more than 50 drones for disaster management.
Wellington, New Zealand	Federal government multi disciplinary team for firefighting, wildfire management, disaster relief, prison operations.
Perth, Australia	State government multi agency team with over 40 drones for cargo, surveillance, incident management, traffic control.
Salina, USA	50 plus drone fleet - State government combined agency team for firefighting, wildfire operations, disaster response, major event planning, law enforcement.
Los Angeles USA	One year programme of engaging residents around introduction of drones and UAM.

Austin, USA	50 plus drone fleet - State government combined agency team for firefighting, wildfire operations, disaster response, major event planning, law enforcement.
Cass County North Dakota USA	Multi-agency first responder drone response agency.

B.2 Class Two Programmes

Programmes in which local authorities have announced partnerships with private industry to develop services, with private industry taking the lead:

Montana, USA	Agreement with Avion Unmanned to provide drone services to public agencies. *https://www.prnewswire.com/news-releases/montana-signs-participating-addendum-with-avion-unmanned-to-provide-drone-services-to-public-agencies-300984617.html*
South Dakota, USA	Agreement with DroneUp to provide drone services to public agencies.
Alaska, USA	Agreement with DroneUp to provide drone services to public agencies.
Utah, USA	Agreement with Avion Unmanned to provide drone services to public agencies.
Hawaii, USA	Agreement with DroneUp to provide drone services to public agencies.
Wake Forest, USA	Developing best practice agreements for fire services and healthcare drone deliveries.

B.3 Class Three Programmes

Programmes in which local authorities are part of a wider programme of stakeholders trialling new technologies, procedures and operational concepts:

Phoenix 1	Liverpool City Region Combined Authority (LCRCA) in partnership with Drone Major Group, to deliver commercially viable, scalable and environmentally sustainable drone services across all environments and sectors including surface, underwater and air. *https://dronemajor.net/editorials/liverpool-city-region-set-to-become-a-global-driving-force-in-drone-technology* *https://www.phoenixmajor.co.uk/projects/phoenixi*
CORUS-XUAM	Very large demonstrator programme executed simultaneously in Germany & UK, to examine optimised urban flight routes structures from airport to city metropolitan area. *https://corus-xuam.eu/*

U-space4UAM	Develop operational concepts, regulation, and standards, while building confidence in a safe and orderly integration of UAM in every day air traffic. *https://cordis.europa.eu/project/id/101017643*
AMU-LED	The project aims to develop a detailed concept of operations and define urban air missions, followed by simulations and a large-scale real flight demonstration campaign to verify and validate the concepts. *https://amuledproject.eu/*
GOF 2.0	The project will demonstrate operational validity of serving combined UAS, eVTOL and manned operations in a unified, dense urban airspace using current ATM and U-space services and systems. *https://gof2.eu/*
SAFIR-MED – Safe and flexible integration in advanced U-space and flexible services focusing on medical air mobility	The project will combine five unmanned UAV platforms (passenger eVTOL, hydrogen fuel cell VTOL, AED medical drone, X8 medical transport) with manned aviation in real-life demonstrations validating technology and the maximum number of U-space services in real urban environment. *https://www.safir-med.eu/*
TINDAIR – Tactical instrumental deconfliction and in flight resolution	The project aims to demonstrate and refine the safety, performance, standardisation and regulatory requirements to enable UAM with specific focus on U-space U3 services identified in the U-space Blueprint and refined by CORUS, and, unlock new and enhanced applications and mission types in high density and high complexity areas. *https://tindair.eu/*
BUBBLES	Defining the BUilding Basic BLocks for a U-Space SEparation Management Service (BUBBLES) project aims to to formulate and validate the concept of a U-space advanced (U3) 'separation management service'
DACUS	Demand and Capacity Optimisation in U-space (DACUS) aims to develop a service-oriented demand and capacity balancing (DCB) process for drone traffic management.
ICARUS	Integrated Common Altitude Reference systems for U-Space (ICARUS) aims to propose an innovative solution to the challenge of the common altitude reference inside very low-level (VLL) airspaces with the definition of a new U-space service and its validation in a real operational environment.
NUAIR/AURA	In May 2021 NUAIR and AURA Network Systems (AURA) announced a collaboration to install infrastructure throughout New

	York's 50-mile unmanned aircraft systems (UAS) corridor, utilizing AURA's secure command-and-control (C2) communication links that provide voice, data, and navigation capabilities for drone flights.
Contingency Management Platform (CMP)	The team will be developing a single, integrated Contingency Management Platform for unmanned aircraft integration, with NUAIR, (Northeast UAS Airspace Integration Research), Oneida County and industry partners
Virginia Flight Information Exchange pilot programme	In August 2020 the Virginia Department of Aviation (DOAV) and Center for Innovative Technology (CIT) announced the launch of a tool that will allow state and local governments to share information among unmanned aerial systems (UAS) stakeholders and address key safety and policy concerns while keeping the airspace open, secure, and integrated with FAA control of the national airspace
Project Xclerate	Establishment of a commercial drone corridor in open and unrestricted airspace, located south of Reading, Berkshire.
Singapore UTM system	Development of a UTM system for multiple drone operations
Dubai, UAE	A UTM and regulatory strategy to launch air taxi services and BVLOS drone delivery flights in Dubai.
Haifa Israel	Development of a trial drone eco system capable of supporting 20 drones simultaneously

Appendix C: High level principles of best practice

(Expanded references for the Summary Report, page 23)

C.1 CORUS X-UAM Early Principles Guide

The CORUS-XUAM project looks at the practicalities of urban air mobility from all angles. A consortium of research institutes, airspace authorities, aircraft manufacturers, unmanned traffic management technology and manned airspace users join forces to ensure all viewpoints are taken into consideration.

1. Limit minimum altitude - to improve privacy and reduce noise

2. Establish no-fly zones for drones – to preserve natural areas, schools, hospitals, etc.

3. Identify strategic location for vertiports – for safety and noise, also for better connectivity

4. Public knowledge about drone technology and operations - transparency

5. Avoid/Limit hovering drone flights – for less noise exposition

6. Promote the use of renewable energy sources to recharge batteries. Use of sustainable aviation fuel for hybrid drones – environment

7. Ensure proper maintenance processes and controls for batteries to extend their life cycle

8. Work with eco-friendly drones (re-cycling parts) – environment

9. Ensure that the cost of drone services remains commensurate with the value of the activity – access to services

10. Developing a risk and safety culture in the drone industry - safety

11. Regulate/limit the time, volume of traffic of drone flights – safety and noise

12. Further research is needed to fully understand the unique acoustics effects of drones – impact on wild life and on persons

13. Fly as fast as possible – less noise exposure

14. Identify the classes of drone operations that can be performed under certain extreme meteorological conditions - safety

15. Developing an environmental protection culture in the drone industry – environment

16. Advertise the environmental benefits of drones (quantification of emission savings) - transparency

17. Establish a Minimum ingress protection code (IP) for drone manufacturers – safety and noise

18. Ensure that electronic devices on drones (cameras, sensors, etc.) cannot be used to infringe on privacy - privacy

19. Give law enforcement the ability to monitor drone traffic directly in U-Space - security

20. Provide a U-Space information service to citizens for the purpose of verifying the mission of a drone – more transparency and less privacy concerns

21. Setting up countermeasures to criminal/illegal use of drones - security

22. Use different methods (like advance encryption standards or regular cyber-attack tests) to improve the security of communications at the UTM system – security

23. Implementing an Artificial Intelligence system capable of detecting any deviant behavior of a drone – safety and security

24. All types of business will be allowed to use UTM services - fairness

25. Conduct early community engagement campaigns to gain public acceptance or reduce public opposition - transparency

26. Improve the accuracy of short-term weather predictions at local and regional level – improves safety and costs

27. Have appropriate insurance in case of damage due to extreme weather events - liability

28. Authorise the use of any drone in search and rescue operations (by diverting it from its original mission), unless its mission is already of an emergency or security nature - safety

29. The transport of sensitive goods and strategic people must be able to be subject to reinforced anonymisation/protection measures in the UTM system - privacy

30. Register cameras – privacy and security

31. Limit type/positions of cameras – privacy and security

32. Create an independent authority to investigate accidents/incidents/complains related to drone operations – transparency and safety

33. Create a public website for the identification and monitoring of public concerns – transparency

34. Ensure that the right level of technical and operational skills/competencies/knowledge are available throughout the drone industry – safety

35. Need for clear rules and insurance to cover potential damage from UAM to third parties, infrastructure and wildlife - liability

36. Quantify and advertise the economic contribution of drones in terms of jobs created and number of people transported, volume and cost of goods transported – transparency

37. Advertise the mobility and economic benefits of drones – transparency

38. Random flight paths to spread drone noise over several ones - noise

39. Equip drones with systems to prevent them from being attacked by birds of prey – safety and environment

40. Regulate the use of lights to reduce light pollution (at night) - environment

41. Strictly limit access to video recordings during and after a drone mission - privacy

42. Fly as slow as possible – preserve animal life

https://corus-xuam.eu/

C.2 The Droneresponders's Five C Code

The Five C's distil key concepts to provide clear guidance that is easy to apply in practice. The principles revolve around five critical pillars:

1. Community Engagement and Transparency

Public service is a public trust. When developing and operating a drone program, it is critical to engage in an ongoing conversation with the community you serve. Effective community engagements consists of two parts: public participation and transparency.

2. Civil Liberties and Privacy Protection

Every drone program should be predicated on the protection of privacy and the promotion of civil liberties. Agencies should develop safeguards and training procedures that advance those objectives across every element of the program.

3. Common Operating Procedures

Departments should develop and adopt common operating procedures to guide the use of drones. The Five C's provide a roadmap for the development of operating procedures that account for best practices in the field on topics such as aviation regulatory compliance and video management practices designed to protect privacy.

4. Clear Oversight and Accountability

Agencies need to establish robust oversight measures designed to ensure compliance and accountability, along with clear oversight processes that combine both internal and external measures.

5. Cybersecurity

Modern drones are more than simple flying machines. Drones have become network-connected devices that should be subject to cybersecurity reviews.

https://www.droneresponders.org/_files/ugd/e60acc_b8b5e91b307f42319ebb92212d051672.pdf

Appendix D: An overview of drone pilot programmes across the World

EUROPE	
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Belgium: Antwerp Port to launch drone eco system – appoints Unifly as industrial partner	https://www.urbanairmobilitynews.com/logistics/antwerp-port-to-launch-drone-eco-system-appoints-unifly-as-industrial-partner/
Bulgaria: The city of Plovdiv signs the Urban Air Mobility Manifesto with an innovative goods transportation system for the integration of urban-rural territories	https://ec.europa.eu/transport/media/news/news/2018-05-30-commission-welcomes-european-cities-joining-urban-air-mobility-initiative_en
Czech Republic: Firefighters use DJI drones and software to provide crucial disaster relief	https://www.suasnews.com/2021/08/firefighters-use-dji-drones-and-software-to-provide-crucial-disaster-relief/?utm_source=DroneNewsDailyEmailMore&mc_cid=87254cc439&mc_eid=d7818dfe0a
Denmark: Healthdrone medical supply programme underway in Odense, Denmark	https://www.urbanairmobilitynews.com/medical-pharmaceutical-transport/healthdrone-medical-supply-programme-underway-in-denmark/
Denmark: Drones released over Funen, Denmark for BVLOS trials	https://www.urbanairmobilitynews.com/medical-pharmaceutical-transport/drones-released-over-funen-denmark-for-bvlos-trials/
Denmark: U-space Funen	https://www.sdu.dk/en/forskning/sduuascenter/researchprojects/u-space-fyn
Estonia: Drones support Estonian emergency services during COVID-19 pandemic	https://www.urbanairmobilitynews.com/first-responders/drones-support-estonian-emergency-services-during-covid-19-pandemic/
Finland/Estonia: Imminent Gulf of Finland SESAR project to trial parcel deliveries by drone between Helsinki and Tallinn	https://www.urbanairmobilitynews.com/express-delivery/imminent-gulf-of-finland-sesar-project-to-trial-parcel-deliveries-by-drone/
France: City of Nice uses drones to enforce the country's lockdown	https://www.urbanairmobilitynews.com/first-responders/one-of-frances-largest-cities-employs-drones-to-enforce-the-countrys-lockdow/
France: Airbus and Hauts-de-France region study drone delivery business opportunities	https://www.urbanairmobilitynews.com/express-delivery/airbus-and-hauts-de-france-region-study-drone-delivery-business-opportunities/

Germany: Hamburg to invest an additional EUR850,000 in urban air mobility projects	https://www.urbanairmobilitynews.com/new-city-projects/hamburg-to-invest-an-additional-eur850000-in-urban-air-mobility-projects/
Germany: Urban UTM trials start in Hamburg to test flight planning, monitoring and detect-and-avoid	https://www.urbanairmobilitynews.com/utm/urban-utm-trials-start-in-hamburg-to-test-flight-planning-monitoring-and-detect-and-avoid/
Germany: Frankfurt University, Merck, Wingcopter test inter-site drone logistics	https://www.urbanairmobilitynews.com/logistics/frankfurt-university-merck-wingcopter-test-inter-site-drone-logistics/
Germany: Medifly demonstrates drone deliveries of medical samples in Hamburg	https://www.urbanairmobilitynews.com/medical-pharmaceutical-transport/medifly-demonstrates-drone-deliveries-of-medical-samples-in-hamburg/
Germany: COVID-19: German drone delivers test samples to lab in 7 minutes	https://dronelife.com/2020/06/04/drone-delivery-for-coronavirus-in-germany/
Greece: Drones trialled at Elefsis Port for delivering medical supplies to shipping	https://www.urbanairmobilitynews.com/logistics/greece-drones-trialled-at-elefsis-port-for-delivering-medical-supplies-to-shipping/
Greece: First Greece and now Spain open their beaches to the public where “drone patrols” play an important role	https://www.urbanairmobilitynews.com/commentary/first-greece-and-now-spain-open-their-beaches-to-the-public-where-drone-patrols-play-an-important-role/
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Ireland: Diabetes medication delivered by drone to Aran Islands	https://www.urbanairmobilitynews.com/express-delivery/diabetes-medication-delivered-by-drone-to-aran-islands/
Italy: Italy expands use of drones to monitor social distancing and movement of people during lockdown	https://www.urbanairmobilitynews.com/first-responders/italy-expands-use-of-drones-to-monitor-social-distancing-and-movement-of-people-during-lockdown/
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Netherlands: Inspection drone trials to be conducted at Amsterdam Airport Schiphol	https://www.urbanairmobilitynews.com/inspection-and-surveillance/inspection-drone-trials-to-be-conducted-at-amsterdam-airport-schiphol/
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Poland: Port of Gdyni hires Pelixar for firefighting and rescue service support	https://www.urbanairmobilitynews.com/first-responders/polish-port-hires-pelixar-for-firefighting-and-rescue-service-support/
Poland: Covid-19: Poland latest country to trial drones for medical deliveries - Warsaw	https://www.urbanairmobilitynews.com/medical-pharmaceutical-transport/covid-19-poland-latest-country-to-trial-drones-for-medical-deliveries/
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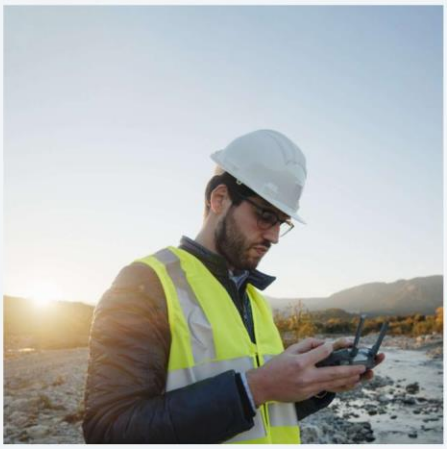

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