



Deployment of Small UAS for Industrial Methane Inspection

Brendan Smith
Chief Technology Officer, SeekOps Inc.
12 May 2022



SPE Webinars are Sponsored by:

SPE
SPE Foundation



Who am I?



- **Hometown:** West Hills, CA (Los Angeles)
- BS and MS in Mechanical Engineering from UC Merced
- 9 years of using drones for



SeekOps

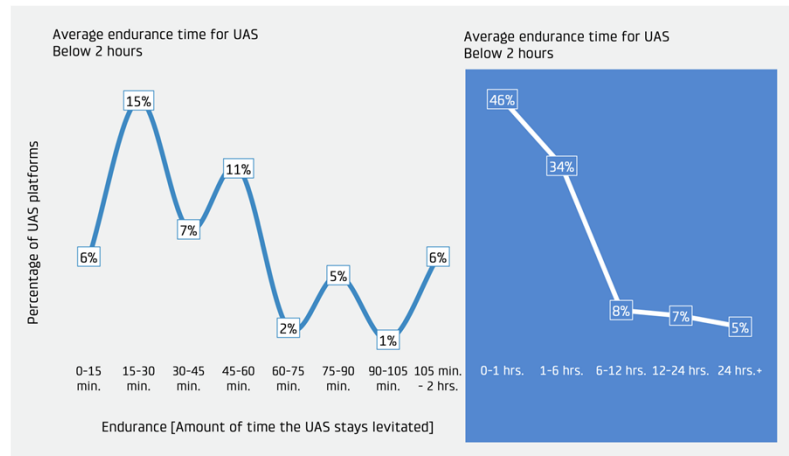
My Graduate Research



- UAS swarming for pipeline leak detection
- Aquatic sampling for Environmental DNA (eDNA) using sUAS
- Air sample collection for Valley Fever using sUAS
- Thermal mapping of Sandhill Cranes at night using sUAS
- Applicability of UAS for Pipeline Leak Detection using in situ sensors
- **JPL** Integration of Methane Sensor on sUAS

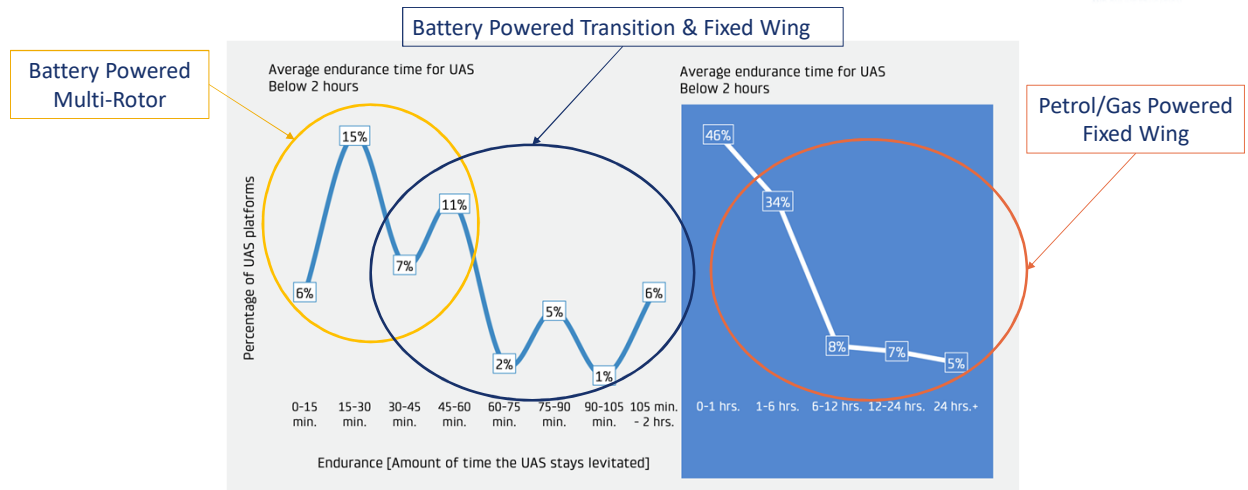


Endurance of UAS Today



Source: Figure 3.3 from "Global Trends of Unmanned Aerial Systems", Danish Technological Institute (DTI) in cooperation with AUUSI (2019)

Endurance of Today's UAS – My View



Source: Figure 3.3 from "Global Trends of Unmanned Aerial Systems", Danish Technological Institute (DTI) in cooperation with AUUSI (2019)

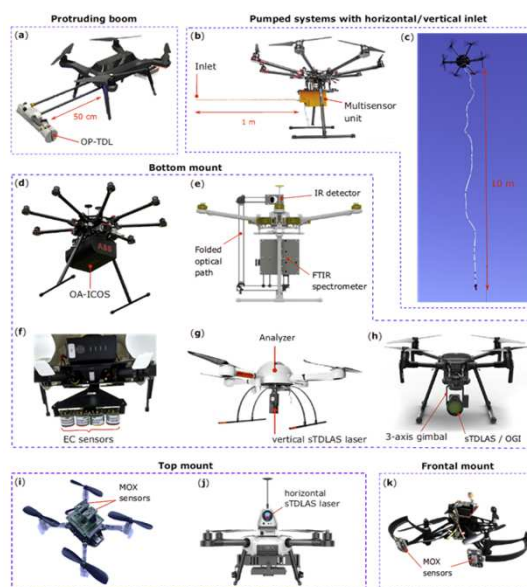
Applications of Industrial Drone Services



- Aerial photography & remote sensing
- **Data acquisition & analytics**
- Mapping & surveying
- Modelling
- Disaster risk management & mitigation
- **Inspection & environmental monitoring**



Application: Environmental Monitoring

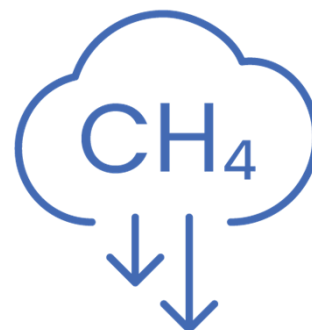


Source: Figure 8 from Burgués, Javier, and Santiago Marco. "Environmental chemical sensing using small drones: A review." *Science of The Total Environment* 748 (2020): 141172.

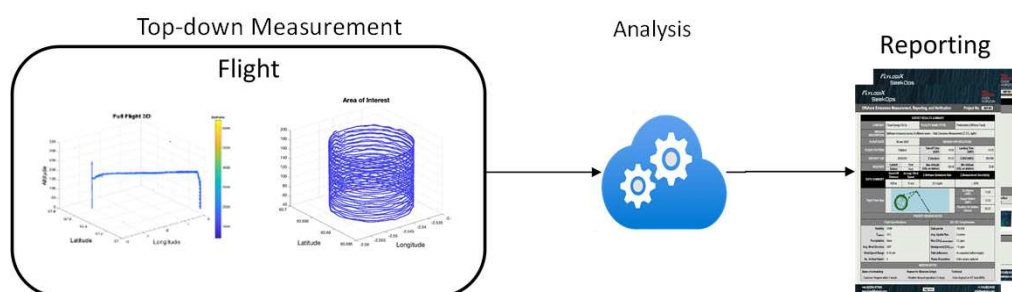
Driver: Methane Emissions Monitoring



- Oil & Gas operators committed to **Net Zero**
- **OGMP 2.0**
 - UNEP Initiative
 - Gold Standard: Accurate Measurement and Reporting
- **COP26 Methane Pledge**
 - Reduce Methane emissions from all sources by **30%**
- **OGCI “Aiming for Zero Methane Emissions” Initiative**
 - Net Zero by 2030 with transparent reporting of emissions, transitioning to measurement technologies
- Emissions reporting frameworks turning focus to **measurement and verification** (*top-down*) in addition to estimation (*bottom-up*) to reach emissions reduction



UAS-Enabled Emissions Monitoring



Focus: Methane Emissions Markets

Conventional Oil & Gas

Onshore & Offshore
Midstream
Plug & Abandonment



Renewable Natural Gas

Biogas/Biomethane
Livestock/Dairy



Waste Management

Wastewater
Landfill Gas



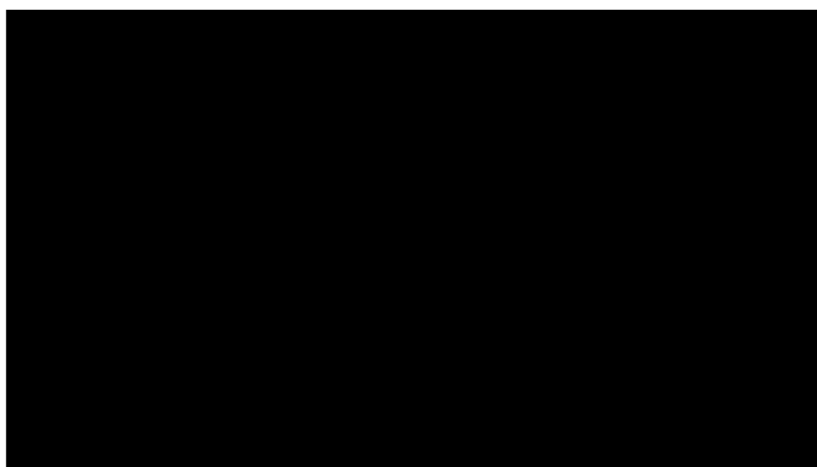
Utilities

Compressors/Pipeline
Gas Storage (LNG)
Metering & Regulation



- Leak Detection & Quantification
- Asset Level for ESG Reporting
- Responsibly Sourced / Certified Gas (MiQ, EO, etc)
- Carbon Credits – particularly biogas/landfill RNG

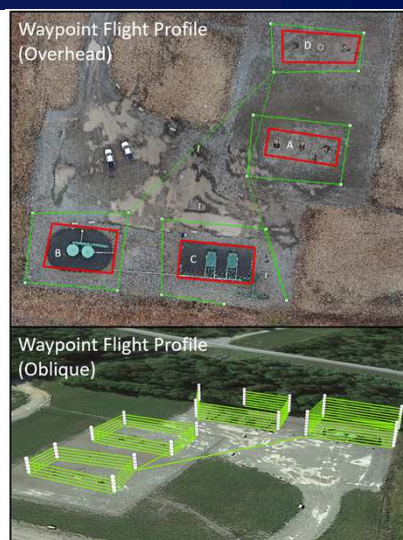
Automation: Onshore Oil & Gas Operations



Automated Survey Flight Planning



- A “Site Setup” was performed at each facility
 - Identify and outline equipment groups
 - Identify obstacles and Intrinsic Safety zones
 - Determine safe flight paths around equipment
- Automated survey flight profiles generated for each site
 - Creates flight “curtain” around equipment groups
 - Fully or partially encompasses equipment group(s)
 - Simultaneously measures upwind and downwind emissions
 - Remain valid indefinitely as long as site layout does not change



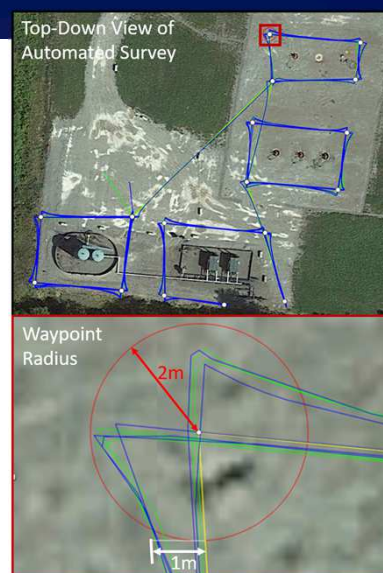
Survey Execution and Repeatability



- Utilized highly accurate RTK guided waypoint missions for automated flight
 - RTK base station must be setup at designated Ground Control Point (GCP) for each survey
 - GCP's were marked at each location
- Reliably followed automated survey waypoint file with consistent margin of error
 - Was able to land on each planned waypoint within a 2 meters radius
 - Was able to stay on planned flight lines within 1 meter



The two survey flight paths (blue and green) are overlaid on top of the planned waypoint flight (yellow and white).



Survey Execution and Repeatability

Flights were extremely repeatable. Multiple survey flight paths were able to be completed within centimeters of each other:



Automation Workflow Example



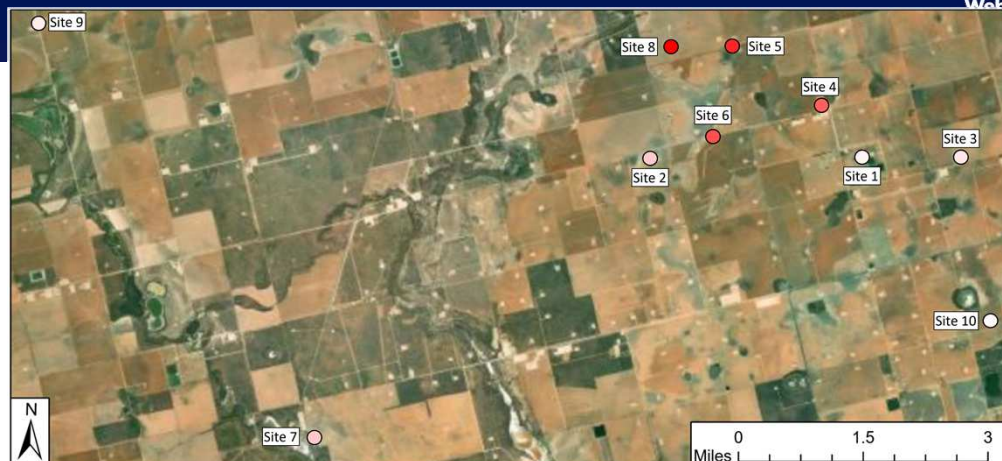
Pad	Survey Group	Emissions Found / OGI Follow-up	Component Source 1	Component Source 2	Component Source 3	OGI Video File Name
1	Wellhead	No				
	Separators	Yes	Level controller	Manifold Flange		
	Tanks	Yes	Thief Hatch N	Thief Hatch S		
2	Pig Launchers	Yes	Barrel Door			
	Wellhead	Yes	Chem Pump			
	Separators	Yes	Regulator Packing			
3	Tanks	No				
	Wellhead	No				
	Separators	Yes	Regulator Packing			
4	Tanks	No				
	Wellhead	Yes	Valve Packing			
	Separators	Yes	Compression Fitting	Flange		
5	Tanks	No				
	Wellhead	Yes	Threaded Connection			
	Separators	Yes	PRV	Level Controller 1	Level Controller 2	
6	Tanks	No				



Work Order for Repair



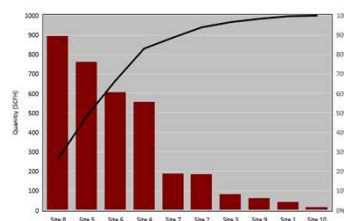
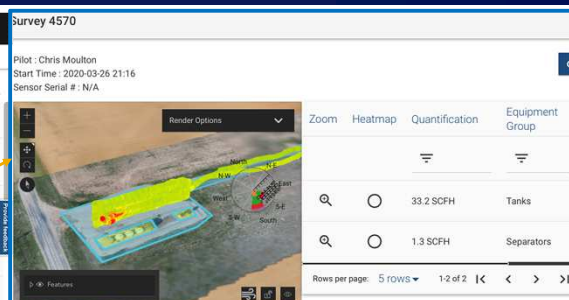
Results: Project Overview – Well Pads



0 SCFH 900 SCFH

Results

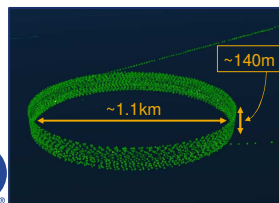
SURVEYS SITES OVERVIEW						
Surveys						
Action(s)	ID #	Start Time	Sensor	Emissions Histogram	Sites	Data Source
	4564	2020-03-26 22:02	0101000010000		MEHARG Placeholder	20200326_79329.dat
	4570	2020-03-26 21:16	0101000010000		WEST ESTATE 1	20200326_76554.dat
	4565	2020-03-26 19:59	0101000010000		SORENSEN 70 1	20200326_71942.dat
	4568	2020-03-26 19:14	0101000010000		WELLS-NICHOLS 5	20200326_69251.dat
	4567	2020-03-26 17:34	0101000010000		HURST Placeholder	20200326_63268.dat



Offshore Deployment: Pilot in Command



Offshore Deployment: BVLOS



Surveys	
Radius	250 - 800 m
Altitude (MSL)	60 - 200 m
Time on Site	30-65 min
Total Flight Time	3 - 8 h

Where do I see the future?



- Expansion beyond Imagery Surveillance and Mapping
 - Sensor suites for precision measurements
 - NDT
 - Manipulation – interfacing with other objects
- Multimodal Sensing
 - A variety of robotics and stationary sensors – leveraging IIOT for communication that is bi-directional
- Dynamic re-tasking
- A lot of cross-pollination from surface or sub-sea robotics



Bottlenecks



- Regulation
 - BVLOS – currently driven by drone delivery
- Technology (far less than we think)
 - Battery / Power source
 - Have experienced a 4x increase in endurance over 5 years from battery optimization
 - Alternative sources – hydrogen, petrol, etc.
 - New battery or power storage technologies
 - Obstacle Avoidance
 - Not ubiquitous across all drone platforms. A couple key players doing it “right”
- Standardization
 - Both Unmanned Systems related and Inspection protocol



Thank You!



- For more details contact:

Brendan Smith bsmith@seekops.com

Office: +1-512-649-8332

