Ohio Department of Transportation

John R. Kasich, Governor
Jerry Wray, Director

Unmanned Aerial Systems: A Look Into UAS at ODOT

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### Post Flight

- **PAPERWORK!!!!!!**
- Flight, Resolution
- Altitude, Battery Voltage
- Flight Time, Wind
- Data check
- Overlap
- Sidelap
- Photo Quality

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**A Look Into UAS at ODOT**
Deliverable Creation

- **Point cloud**
  - Exported in multiple formats
  - Example .las

- **Orthophoto**
  - Exported in google tiles and geotiff

- **Textured Mesh**
  - Meshed surface with the orthophoto referenced
Deliverable Creation Continued

A Look Into UAS at ODOT
Orthophoto
Deer Creek Test

Outlined area was tested against our manned aircraft & topographic surveying using a total station.

A Look Into UAS at ODOT
Deer Creek Test

<table>
<thead>
<tr>
<th>Greater than 1.00 ft.</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50 ft. to 1.00 ft.</td>
<td>C</td>
</tr>
<tr>
<td>0.25 ft. to 0.50 ft.</td>
<td>B</td>
</tr>
<tr>
<td>-0.07 ft. to 0.07 ft.</td>
<td>A</td>
</tr>
<tr>
<td>-0.25 ft. to -0.50 ft.</td>
<td>B</td>
</tr>
<tr>
<td>-0.50 ft. to -1.00 ft.</td>
<td>C</td>
</tr>
<tr>
<td>less than -1.00 ft.</td>
<td>D</td>
</tr>
</tbody>
</table>

Flight @ 235.4 AGL 60% Lateral & 75% Longitudinal Overlap

Flight @ 353.5 AGL 60% Lateral & 75% Longitudinal Overlap

A Look Into UAS at ODOT
Deer Creek Test

Flight @ 353.5 AGL 60% Lateral & 75% Longitudinal Overlap

Combined Flights @ 353.5 and 235.4

A Look Into UAS at ODOT
eBee Plus

A Look Into UAS at ODOT
Platforms

A Look Into UAS at ODOT
A Look Into UAS at ODOT
ODOT Moving Forward

- Reviewing FAA guidelines to evaluate ODOT safety and policy needs that will need to be required above FAA regulations (i.e. may require additional observers, liability insurance, develop additional privacy policies, public notifications, etc.)
- Once all specifications and policies are in place, will develop prequalification process for contractors and consultants
- Will evaluate program expansion to DOT District Survey Offices
  - As well as expansion to other business areas within ODOT
Hurdles with the Start of a UAS Program

- Waviers and Regulations
- Rogue Operators
  - Over 583 UAS sightings reported by pilots in the last 6 months
  - Halted firefighting operations in California wildfires
- Preparing the Proper Workflow and Safety Plan
- Deciding and Evaluating a Platform
- Sensors and Airframe

A Look Into UAS at ODOT
Ohio Contacts/ Information for UAS

Indiana/Ohio UAS Center and Test Complex:

http://www.dot.state.oh.us/Divisions/uas/Pages/default.aspx

Ohio Department of Transportation:

Questions?

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A Look Into UAS at ODOT
ODOT’s Current Position

Flight Operation Testing

- Accuracy Assessment
- ODOT Business Policy
- Processing Workflow
- Deliverables
  - Several active COAs
    - LAW-52 and Deer Creek State Park
  - Section 333 Exemption
  - Flying under Part 107

A Look Into UAS at ODOT
Part 107 Small Unmanned Aircraft Regulations

- Released June 21st, 2016
- Effective August 2016
- Responded to Notice of Proposed Rules call for comments
- Over 600 pages!
PART 107: In Summary

Operational Limitations

- Weigh less than 55 lbs.
- Visual line-of-sight (VLOS)
- Daylight-only operations
- Must yield right of way to other aircraft
- Visual observer (VO) not required
- Maximum groundspeed of 100 mph (87 knots)

- Minimum visibility of 3 miles from control station
- Small unmanned aircraft may not operate over any persons not directly participating in the operation, not under a covered structure, and not inside a covered stationary vehicle*
PART 107: In Summary

Operational Limitations Continued

- Maximum altitude of 400 feet above ground level (AGL) or, if higher than 400 feet AGL, remain within 400 feet of a structure*

- Operations in Class B, C, D and E airspace are allowed with ATC permission

- No person may act as a remote pilot in command or VO for more than one unmanned aircraft operation at one time

- No operations from a moving vehicle unless the operation is over a sparsely populated area.

A Look Into UAS at ODOT
PART 107: In Summary

Operational Limitations Continued

❖ Requires preflight inspection by the remote pilot in command***

❖ Most of the restrictions discussed are waivable if the applicant demonstrates that his or her operation can safely be conducted under the terms of a certificate of waiver

❖ Process to receive a waiver to the restrictions not in place
PART 107: In Summary

Remote Pilot in Command Certification

A person operating a small UAS must either hold a remote pilot airman certificate with a small UAS rating or be under the direct supervision of a person who does hold a remote pilot certificate.
PART 107: In Summary
Remote Pilot in Command Certification

To qualify for a remote pilot certificate, a person must:

- Demonstrate aeronautical knowledge by either:
  - Passing an initial aeronautical knowledge test at an FAA-approved knowledge testing center; or
  - Hold a part 61 pilot certificate other than student pilot, complete a flight review within the previous 24 months, and complete a small UAS online training course provided by the FAA.
- Be vetted by the Transportation Security Administration.
- Be at least 16 years old.
PART 107: In Summary

**Remote Pilot in Command Responsibilities**

- Make available to the FAA, upon request, the small UAS for inspection or testing.
- Report to the FAA within 10 days of any operation that results in at least serious injury or property damage of at least $500.
- Conduct a preflight inspection
- Ensure that the small unmanned aircraft complies with the existing registration requirements specified in § 91.203(a)(2).
- FAA airworthiness certification is not required
  - Not platform dependent!
ODOT’s Current Platform: SenseFly eBee RTK

- **Weight**: 1.61 lb including camera
- **Wingspan**: 38 in.
- **Material**: EPP foam, carbon structure & composite parts
- **Propulsion**: Electric pusher propeller, 160 W brushless DC motor
- **Battery**: 11.1 V, 2150 mAh
SenseFly eBee RTK

**Hardware**

- Connects directly into the CORS RTK network for survey grade accuracy and real time corrections. (L1/L2, GPS and GLONASS)
- 3 cm horizontal and 5 cm vertical accuracy without ground control pts.*
- Canon WX (18.2 MP) auto-triggering camera
- 40 min. max flight time

During the duration of this presentation the eBee RTK can map a 4.5 square mile area (lowest resolution at the highest altitude)

More typical flight 50 acres (2.5 cm per pixel) in less than 10 minutes*

*Perpendicular flight lines
SenseFly eBee RTK

Software

- eMotion
  - Flight Planning and Control Software
- Postflight Terra 3D → Pix4D
  - Professional Photogrammetry Software
eMotion

Flight Planning and Control Software

- **Planning**
  - Allows user to use 3D mission planning to plan the perfect flight.

- **Simulation**
  - Puts the perfect flight plan to the test in 3D with the UAS safely on the ground.

- **Monitoring and Control**
  - Using the same interface the operator can control and monitor the UAS in flight.

A Look Into UAS at ODOT
Check in the Field
Provides a quick quality report in the field to insure proper coverage and accuracy

Generate Orthos, 3D models & Point Clouds
Creates deliverables directly into the remote sensing workflow. (.las and georeferenced tiff images)
Remote Sensing Deliverables

- Orthomosaic Raster
- 3D Point Cloud in .las format
- DSM in a geoTIFF
- 3D Textured Mesh
- Contours
- Imagery in .tif format
ODOT Best Practices and Workflow

Planning → Simulation → Site Preparation → Flight Operations → Processing and Deliverables
Planning

Site Reconnaissance

- Obstacles
  - Trees
  - Utilities
  - Airports
- Safe Zones
- Primary and Alternate Landing Sites
- Access Control

A Look Into UAS at ODOT
A Look Into UAS at ODOT
Site Preparation

- Ground Truth
- Day of Flight Conditions
  - Obstacles
  - Weather
  - Site Access
- Internet Connection
- Line of Sight
Flight Operations

- **Pre-flight checks**
  - Airframe Condition
    - Wings, Propeller, Pitot Tube, Ground Proximity Sensor, Batteries, Camera, etc.
  - Crew Briefing on Operations
  - Flight Plan Upload
    - Check parameters, set landing point, etc.
  - Document Operations and variables
Flight

A Look Into UAS at ODOT