It’s Time to Fly! Do You Know What You’re Getting Yourself Into?

Cody Schneider, PS, EI
Survey Phase Manager, Woolpert, Inc.
Overview

- Types of Unmanned Aerial Systems
  - VTOL (Kespry)
  - Fixed Wing (Altavian)
  - Cessna 182 “Surrogate UAS”

- Utilizing the Appropriate System

- FAA UAS Regulations: Part 107

- How can UAS be Applied to the Transportation Industry?
  - Review of ODOT Surveying Specifications
  - The Need for Traditional Surveying

- Understanding the Accuracy
  - Test Site A
  - Quantifying the Accuracy of a System

- Cost/Benefit Analysis

- Conclusions

- Sample Projects
  - Portsmouth Bypass
  - Senecaville Well Pad

- Questions
Types of Unmanned Aerial Systems

**Vertical Takeoff and Landing (VTOL)**

- Commonly referred to as quadcopter, multicopter, or helicopter
- Takes off and lands vertically, hovers
- Relatively less user interaction necessary—controlled movement
- Limited battery life and groundspeed—less capture area
Types of Unmanned Aerial Systems

Fixed Wing

• Generate lift with forward airspeed and shape of frame

• Requires open areas for takeoff/landing

• Suitable for corridor mapping

• Greater battery life and groundspeed
Types of “Unmanned” Aerial Systems

Cessna 182 “Surrogate UAS”

- Unaffected by FAA UAS Regulations
- Provides an alternative for UAS-challenged areas
- Suitable for larger areas
- Capable of producing 2cm GSD
Utilizing the Appropriate System

Spatial resolution
Spectral resolution
Geographic size AOI

UAS “Fixed Wing”
UAS “VTOL”
Cessna 182 “Pod System” or “Surrogate UAS”
Cessna 404 “Traditional”
Aerial Commander

Persistence
Altitude

What about for transportation projects?

Planet Labs Satellite Imagery

Cadence
FAA UAS Regulations: Part 107

- These rules help define whether or not UAS can be used on a given transportation project.

- Breakthrough set of rules that help define commercial UAS operation.

- Useful changes with Part 107:
  - No pilot requirement
  - No visual observer requirement
  - Can conduct more operations with air traffic control tower (ATCT) permission
  - If higher than 400 ft AGL, UAS is allowed to fly within 400 ft of a structure.

<table>
<thead>
<tr>
<th>Before (333 exemption)</th>
<th>After (Part 107)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot’s license + 333 exemption</td>
<td>Remote Pilot Certificate</td>
</tr>
<tr>
<td>6 month queue for 333 exemption funneled through 1 FAA department</td>
<td>Knowledge test vetted by TSA and administered at 700 centers around the US</td>
</tr>
<tr>
<td>Medical Certificate</td>
<td>Drivers License</td>
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<tr>
<td>Spotter required (2-man crew)</td>
<td>No spotter required</td>
</tr>
<tr>
<td>Required to file NOTAM</td>
<td>No NOTAM required</td>
</tr>
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FAA UAS Regulations: Part 107

Remaining Regulations

• Unspecific language about direct participants
  • Can signs be placed or authorities notified?

• Still required to maintain line of sight
  • 1 mile radially from ground control station

• Certificates of waiver can still be granted
ODOT Surveying and Mapping Specifications

- These specifications provide the framework for survey data used with engineering design
- Two sections primarily apply to UAS: DTM and Planimetric mapping
- At first glance, planimetric benchmarks seem attainable
- DTM specs for paved areas are particularly low

<table>
<thead>
<tr>
<th>DTM Accuracy Class</th>
<th>Recommended Use</th>
<th>Maximum Allowable Average Dz (feet)</th>
<th>Maximum Allowable RMSE (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A</td>
<td>Paved areas</td>
<td>± 0.07</td>
<td>0.16</td>
</tr>
<tr>
<td>Class B</td>
<td>Vegetated areas outside of pavement that are maintained at a minimum biannual frequency (i.e.: farm fields, residential yards, roadside R/W, etcetera)</td>
<td>± 0.25</td>
<td>0.32</td>
</tr>
<tr>
<td>Class C</td>
<td>Vegetated areas that are not maintained</td>
<td>± 0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Class D</td>
<td>Areas where vertical accuracy is not critical or warranted (i.e.: planning engineering projects)</td>
<td>± 1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Planimetric Accuracy Class</th>
<th>Recommended Use</th>
<th>Maximum Allowable RMSE (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>Projects that require Class I planimetric features listed in Appendix A to be identified and mapped (i.e: design engineering projects)</td>
<td>0.30</td>
</tr>
<tr>
<td>Class II</td>
<td>Projects that require Class II planimetric features listed in Appendix A to be identified and mapped (i.e: planning studies)</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Additional Points of Discussion

- Traditional survey is still needed to meet specifications:
  - Tie to primary control
  - Establish benchmarks
  - Aerial targets/ground control
  - Hard and soft shots
  - DTM check shots
  - Planimetric check shots
  - Utilities
  - Boundary survey

- Costs can quickly add up

- Flexibility on the specifications?
Understanding the Accuracy

Testing Our Platform

- Test Site A:
  - 11 acre site
  - Contained roadways and was relatively unobstructed

- Opted to test this location with our Kespry quadcopter
  - ≈15 mph groundspeed
  - Sony ILCE 5100 camera
  - 350 ft AGL
  - Target GSD 2.7 cm

- Goals:
  - Categorize positional accuracy for digital elevation data and colorized point clouds
  - Evaluate the correlation between ground control and product accuracy
Understanding the Accuracy
Understanding the Accuracy

Independent Accuracy Checks

• A second survey was conducted using independent accuracy checks

• Multiple data sets were incorporated:
  • Surveyed GCPs not part of AT
  • Surveyed drain covers and stormwater manholes
  • Points extracted from curb and gutter linework

• All data in NAD83 (2011)

Which control network performed the best?
Understanding the Accuracy

Is there a correlation between control and product quality?
GCP Processing Comparisons

- Processing Session E performed the best
- Processing Session B performed the worst
- Vertical RMSE change from C to D is significant
- Diminishing returns with control
Textured 3-D Model
Quantifying the Accuracy

Do we feel that the Kespry can meet ODOT specs?

- Processing Session E:
  - Horizontal RMSE: 0.225 ft
  - Vertical RMSE: 0.232 ft

- All specs but DTM paved area appear to have been met

- 1 foot contours appear to be attainable

- Planimetric specifications are achieved

- Perfect site, with minimal obstacles

- Trying other platforms and/or camera systems
Cost/Benefit Analysis

- Difficult to apply a blanket comparison between particular types of acquisition
- Projects should be evaluated on a case-by-case basis
- Can be used for the ideal site (≈ 2 mi)—federal regulations and accuracy concerns make anything else challenging

<table>
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<th>Comparison Between UAS and Traditional Methods</th>
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<tbody>
<tr>
<td>Traditional Surveying</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
</tr>
<tr>
<td><strong>Approximate Cost Savings with UAS</strong></td>
</tr>
<tr>
<td><strong>Time</strong></td>
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Cost/Benefit Analysis

• Aside from the initial cost benefit, UAS provides new deliverables and quicker product turnaround

• Traditional survey has concerns:
  • Interpolation
  • Human error
  • Different ways of collecting the dataset
  • Safety
Conclusions

• Consider the appropriate system for your business

• Be wary of vendors promising more than they’re capable of

• UAS is a niche service, and should not be treated like a complete solution

• Ideal for smaller (≈ 2 sq. mi.) capture areas that are free of obstacles and not hindered by FAA regulations

• Can perhaps be applied to transportation projects with steady coordination with the authoritative agency
Sample Projects

Portsmouth Bypass

- Joint venture effort to develop a 17 mi, 4 lane, limited access highway bypass

- Collected with our Surrogate UAS platform

- Project area was too complex to rely on standard UAS:
  - Size of project
  - Limited visibility
  - Dynamic construction
Sample Projects
Sample Projects

**Senecaville Well Pad**

- Collected with our Altavian fixed wing platform
- Dynamic terrain presented challenges for fixed wing operation
- Overall accuracies were greater than comparable sites flown with VTOLs
Questions?

Cody Schneider
Phone# 937.531.1633
Cody.Schneider@woolpert.com

Aaron Lawrence – Woolpert UAS R&D
Phone# 937.531.1323
Aaron.Lawrence@woolpert.com