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Civil Engineering Applications of Drones


January 17, 2016
11:00AM to Noon

Presented by:
Chris Cornwell P.E., LEED®AP, Civil/Highway Manager
GPI/Greenman-Pedersen, Inc.
and
Casey Knapp, P.E., Project Manager
GPI/Greenman-Pedersen, Inc.


Drones - What do you think of?



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Overview of Today's Presentation

- Terminology, History, and Growth of Drone Industry
- State of Regulations
- Types of Drones
- Potential Uses
  - *Bridges*
  - *Cell Towers*
  - *High Mast Lighting*
  - *Wind Turbines*
  - *Power Lines*
  - *Building Facade and Roof*
  - *Survey and Mapping*
  - *Construction Monitoring*
  - *Wetland/Environmental*
  - *Drainage and Erosion*
  - *Traffic Monitoring*
  - *Emergency Services*
- Software Applications and Processing
- Considerations for uses
- PDH's and Open Discussion

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Drone Terminology

- UAV - Drone and/or Unmanned Aerial Vehicle
- UAS - Unmanned Aircraft System
- sUAS - Small Unmanned Aircraft System
- PIC - Pilot in Command
- FAA - Federal Aviation Administration
- NAS - National Air Space
- NOTAM - Notice to Airman

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Brief History

- Early 2000's significant advances in electronics (computers, GPS, etc)
  - *Development of first mainstream commercial quadcopter in 2010*
- 2012 FAA Modernization and Reform Act
  - *Required FAA to develop regulations for integrating UAS into the NAS*
  - *Section 333 of the Act permitted case by case exemptions for commercial use of UAS in the NAS*
  - *First Section 333 Exemption granted September 25, 2014*
- February 23, 2015 Notice of Proposed Rulemaking
  - *Draft Operation and Certification of Small Unmanned Aircraft Systems*
- December 14, 2015 FAA requires all UAS be registered via on-line system
- June 28, 2016 Final Rulemaking – Part 107
  - *Effective August 29, 2016*

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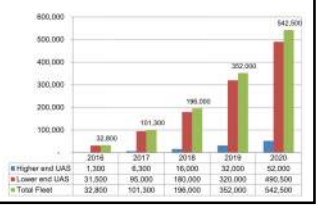
Growth of Drone Industry

- Overall Drone Market projected to reach over 5 Million Units/year by 2024
- Growth rate at over 32% year
- Growth has resulted in technology outpacing regulations and uses
- Changes in FAA regulations has made commercial use more accessible
- FAA Aerospace Forecast on Commercial Use
  - *2016 to 2036*
  - *1,554% Increase*



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State of Regulations – Section 333

Prior to August 29, 2016
All Drone Commercial Flights had to be:

- Less than 400 feet vertical
- Within Visual Line of Sight
- Licensed Pilot and Visual Observer (non-licensed)
- Not closer than 5 miles from airport
- At least 500 feet from any non-participating person
- File NOTAM for each flight
- Flight Reporting to FAA


Federal Aviation Administration

Authorizations Granted Via Section 333 Exemptions

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State of Regulations – Part 107

Effective August 29, 2016
Title 14 of the Code of Federal Regulation (14 CFR) Part 107

- Requires a Remote Pilot Airman Certificate
- Requires FAA aircraft registration
  - *FAA Small Unmanned Aircraft System (sUAS) Registration Service*
- Aircraft must be less than 55 pounds
- Class G airspace*
- Must maintain visual line of sight*
- Must fly under 400 feet or within 400 feet of a structure*
- Must fly during the day*
- Must fly below 100 mph*
- Must NOT fly over people*


FAA News
Federal Aviation Administration, Washington, DC 20591

These rules are subject to waiver with FAA approval

Existing 333 Exemptions holders may choose to fly under Section 333 or Part 107

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Types of Drones

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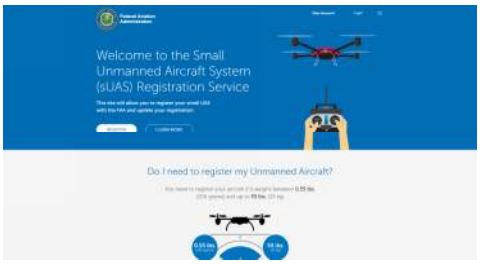
State of Regulations – Part 107



https://registermyuas.faa.gov/

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National Airspace System

Controlled Airspace

- Class A Airspace– Generally 18,000 feet up to Flight Level 600
- Class B Airspace – Generally surface to 10,000 feet
- Class C Airspace – Generally surface to 4,000 feet
- Class D Airspace – Generally surface to 2,500 feet
- Class E Airspace – Controlled airspace not classified as Class A, B, C, D

Uncontrolled Airspace

- Class G Airspace – uncontrolled airspace that is not designated as Class A, B, C, D. Extends from surface to to the base of the overlying Class E Airspace

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Potential Applications

- Most civil engineering structures have routine inspection frequencies
- Aging infrastructure has placed increased emphasis to ensure structures perform as originally designed
- **Problem:**
  - Traditional Inspections require significant manpower and equipment resulting in increased costs
  - Many inspections provide risk to inspection staff, impacts to traveling public, and or potential damage to the structure
- **Potential Benefits of Using Drones:**
  - Drones as another tool in the engineering tool box
  - Drones to supplemental current inspections practices
  - Drones into standard engineering inspection practice
  - Adjust type and frequency of inspections

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2016 NYS Demonstrations

- Nationwide DOT's considering adaptation of Drones
- AASHTO Survey of State DOTS's (2016) found 33 DOT's considering Drone Program
- Private industry is taking lead with Drone applications
- Demonstrations performed in the Summer of 2016 for various NYS Agencies
  - *New York State DOT*
  - *New York State Thruway*
  - *New York State DEC*
  - *New York State Department of Ags, and Markets*
  - *New York State Chamber*
  - *New York State Division of Military and Naval Affairs*
  - *New York State Homeland Security Emergency Services*
  - *New York State Department of Corrections*
  - *New York State Police*
  - *New York State Office of Parks*
  - *New York State OGS*

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NEW YORK STATE OF OPPORTUNITY. Thruway Authority | Canal Corporation

2016 NYS Demonstrations

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2016 NYS Demonstrations

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Bridge Inspection – Traditional Methods

- Traditional Methodology
  - Climbing
  - Manlifts
  - Scafolding
  - Barges
  - Snoopers
- Requires Significant Work Zone Traffic Control
- 23 CFR Part 650 - National Bridge Inspection Standards requires inspection frequency of 2 years






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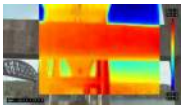
Bridge Inspections – Drone Methods

- Potential Uses
  - Deck Delamination
  - Slabs Underside
  - Paint System
  - Girders
  - Trusses
  - Connections
  - Floor beams
  - Columns/Piers
  - Bearings
  - Fracture Critical Members



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Canal/Dam Inspections – Drone Methods







- Potential Uses
  - Canal structures
  - Dam Structures
  - Flood Assessment

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Cell Tower Inspections – Traditional Methods

- Traditional Methodology
  - Climbing
  - Man lifts
- To Perform
  - Document structural condition
  - Connections
  - Hardware Assessment
  - Mapping of Assets



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Cell Tower Inspections – Drone Methods



- Potential Benefits
  - Reduced time on Site
  - Reduced coordination with Owners
  - Geo-Referenced Imagery
  - No equipment rental
  - Increased Safety
  - No need for Fall Protection
  - Reduce accessibility concerns

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High Mast Lighting – Traditional Methods

- Traditional Methodology
  - Spotting Scopes
  - Spider Baskets
  - Manlifts/Bucket Trucks
- To Perform
  - Structural Condition
  - Connections - Slip Joints
  - Electrical



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High Mast Lighting – Drone Methods






- Potential Benefits
  - Increase Safety
  - Reduce access concerns
  - No need for fall protection
  - Less time on site
  - Less coordination with owners

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Wind Turbine Inspection – Drone Methods

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Power Transmission Lines– Drone Methods

- Potential Benefits
  - *No need to shut down power*
  - *Inspection of Cor-Ten Structures*
  - *Hanger Assembly Inspection*



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Building Facade/Roof – Traditional Methods

- Traditional Methodology Concerns :
  - Safety
  - Accessibility
  - Fall Protection
  - Time on Site
  - Coordination
  - Damage to Structure

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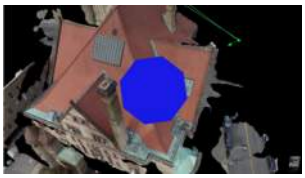
Building Facade/Roof– Drone Methods



Conducted in Accordance with ASTM WK52572

- Guidelines for Utilizing Drones to document Façade
- Requires systematic notation system
- Access areas typical not accessible
- Observe areas not visible from the ground
- Document damaged masonry

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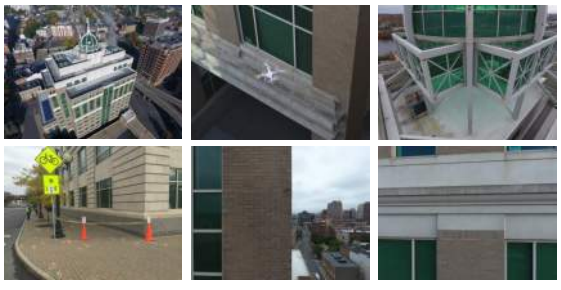
Building Facade/Roof– Drone Methods



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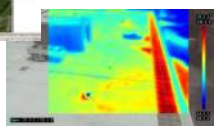
Building Facade/Roof– Drone Methods

NYSTA HQ
Google Image

Mission



Output High
Resolution
Imagery

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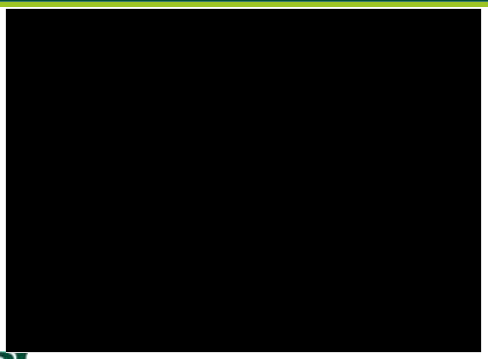
Building Facade/Roof– Drone Methods



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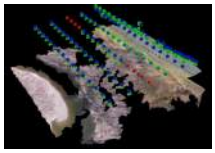
Survey and Mapping – Drone Methods



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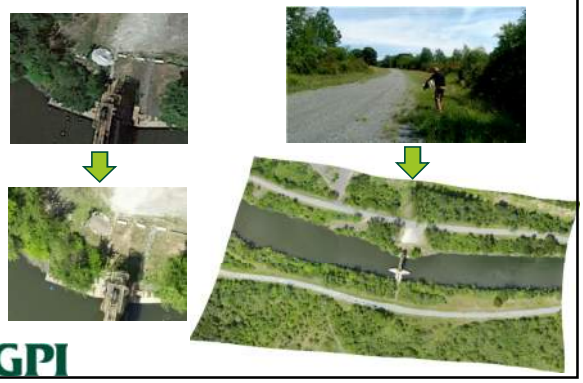
Survey and Mapping – Drone Methods



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Survey and Mapping – Rail – Drone Methods

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Volumetric Calculations – Drone Methods

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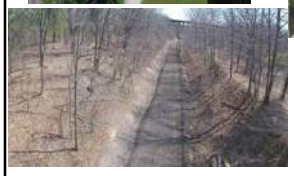
Construction Monitoring – Drone Methods



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Wetland/Environmental – Drone Methods




- To Perform
  - Stream Restorations
  - Reach hard to access areas
  - Count wildlife
  - Monitor Stream Erosion
  - Identify plant species
  - Reduce survey time

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Erosion Monitoring – Drone Methods

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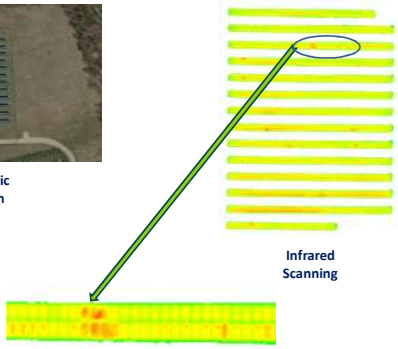
Solar Field – Drone Methods

Orthomosaic Generation



Infrared Scanning

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Traffic Monitoring – Drone Methods

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Case Study – Emergency Services

- To Perform
  - Initial Assessment
    - *Fires*
    - *Building Collapses*
  - Ice Rescue
  - Accident Scene Reconstruction
  - Search and Rescue

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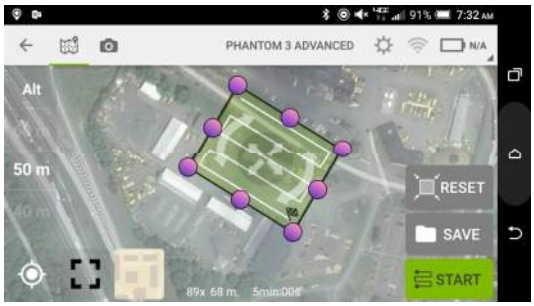
Software Case Study



Tablet Application

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Software Case Study

Collection of Individual Images

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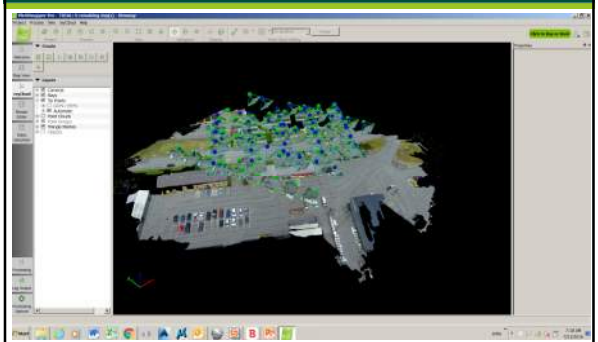
Software Case Study



Camera Locations

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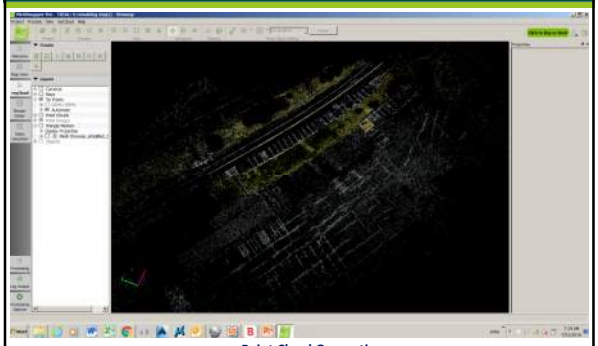
Software Case Study



Point Cloud Generation

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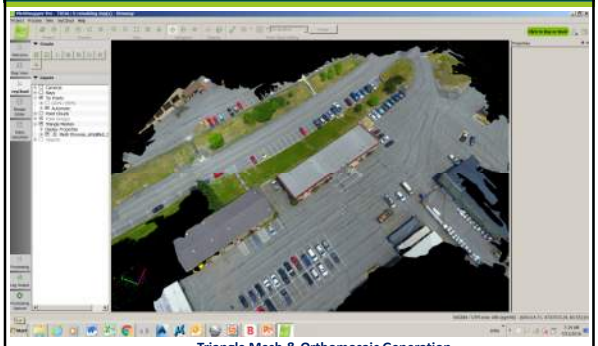
Software Case Study



Triangle Mesh & Orthomosaic Generation

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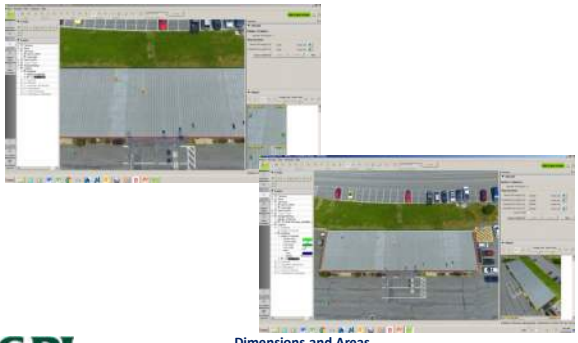
Software Case Study



Dimensions and Areas

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Drone Considerations

- Reduction in field time for inspection and increase safety
- Reduction in field costs
- Limit exposure to field personal risks
- Provide access to difficult locations
- Infrared scanning to see internal structure problems
- Capture videos and pictures of problem areas
- Requires some training and skilled use
- Difficult to navigation around/under obstacles
- Surrounding Object Interferences
- Not a hands on inspection
- Airspace and regulations
- Weather: *Rain, Wind, Temperature*
- Technology: *newer technologies, Image and Video formatting, compatibly, file sharing, data storage, computer and post processing*
- Adoption by Engineering Community and Owners
- Insurance

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PDH Questions

1. **What are the prior and current FAA regulations controlling Drones in the US?**
   a. **Section 333 and Part 107**
   b. **Section 106 and Part 617**
   c. **There aren't any – fly them where ever you want**

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PDH Questions

2. **Class G airspace is considered controlled airspace by FAA? True or False**

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PDH Questions

3. Part 107 of the FAA regulations on Small Unmanned Aircraft Apply to aircraft under 55 pounds? True or False

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PDH Questions

4. What are some benefits of utilizing Drones for inspections?
   a. Reduce Field Time
   b. Limit Risk
   c. Reach hard to access locations
   d. All of the above

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PDH Questions

5. What are some potential applications for Drone use in Civil Engineering?

   Bridges, Cell Towers, High Mast Lighting, Power Lines, Building Facades, Surveying and Mapping, Construction Monitoring, Drainage and Erosion, Emergency Services, Traffic Simulations

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Civil Engineering Applications of Drones

Please take this time for open discussion and questions

Chris Cornwell P.E., LEED®AP, Civil/Highway Manager
GPI/Greenman-Pedersen, Inc.
ccornwell@gpinet.com
518.898.9512

Casey Knapp, P.E., Project Manager
GPI/Greenman-Pedersen, Inc.
cknapp@gpinet.com
518.898.9524

gpinet.com