UAV (AKA DRONE)
TECHNOLOGY IN TRANSPORTATION PROJECTS

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WASHINGTON STATE COUNTY ROAD ADMINISTRATION (CRAB)

Washington State Transportation Commission
Meeting March 15th, 2016
Purpose of presentation is to:
Provide a fundamental understanding of UAV's and how they can operate Safely and Effectively in Transportation Projects.

Contents:
1. UAV Applications in the Public Arena.
2. History and types of Drones & UAV’s.
3. Why should we use UAV's for Transportation Projects?
4. Examples of Fixed Winged UAV’s & Rotary UAV’s.
5. How to utilize the UAV data for Transportation purposes.
6. Current FAA authorization requirements to fly an UAV.
UAV Applications in the Public Works Arena

- Information Technology is one of CRAB’s Core Missions.
- Investigate and research innovative, cost effective, technical strategies for counties for possible implementation.
- Drone or UAV’s (Unmanned Aerial Vehicles) technology has grown rapidly over the last decade and the future growth is almost assured.
- Data obtained from UAV’s is 1% to 10% of the cost of conventional aircraft.
- Owner controlled data with better quality, clarity, and safer.
- Data gathered and processed for usage more quickly.
UAV Applications in the Public Works Arena

- **Inspections**
  - Existing Bridge Structures (routine, damage, replacement)
  - Quarry and pit site operations and depletion surveys
  - Waste site operations and cell development surveys
  - Construction project progress and conflict resolution surveys

- **Mapping and Surveying**
  - Aerial Photography
  - LIDAR data for 3D modeling of surfaces
  - Environmental assessments and evaluations
UAV Applications in the Public Works Arena

- Observation and Monitoring
  - Wildland Fire
  - Search and Rescue
  - Environmental Incidents
  - Transportation Incidents
  - Pre-emergency/disaster reconnaissance and warning systems
  - Emergency/disaster response
  - Post-emergency/disaster recovery efforts
- Legal records and documentation
Jim Ayres, P.E.
Washington State County Road Administration Board (CRAB)

* Design Systems Engineer CRAB
  1999- present

* Grays Harbor County Public Works
  Civil Engineer 1986 -1999

* BSCE St. Martin’s University ‘86
**DRONE (pre UAV) History**

- **Early 1940’s German V1 – Buzz Bomb**
- **2000’s M-9 Reaper**
- **Military Insect UAV (rumored)**
- **2000’s Remotely Piloted Vehicle (RPV)**
- **Today’s Hobbyist Drones**
UAV/UAS Altitude by Class

<table>
<thead>
<tr>
<th>Class</th>
<th>Altitude (feet)</th>
<th>Endurance (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAE</td>
<td>70K</td>
<td>10</td>
</tr>
<tr>
<td>Global Hawk</td>
<td>60K</td>
<td>20</td>
</tr>
<tr>
<td>Heron 1</td>
<td>50K</td>
<td>30</td>
</tr>
<tr>
<td>Heron 2</td>
<td>40K</td>
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<td>Predator A</td>
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<tr>
<td>Predator B</td>
<td>20K</td>
<td>10</td>
</tr>
<tr>
<td>Eagle Eye</td>
<td>10K</td>
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</tbody>
</table>

UAV's

Commercial

Medium

Tactical

Endurance (hours)

Altitude
Filling The Gap (Infographic)

UAV’s vs Other Geospatial Data Sources

- Extensive coverage
  - Wide spectral capabilities including LiDAR
- Relatively low-resolution (down to 30 cm/pixel)
  - Image timing controlled by provider
  - Limited coverage in some regions
  - Imagery susceptible to cloud cover

- Large single-flight coverage
  - High-resolution (down to 7 cm/pixel)
  - Wide spectral capabilities including LiDAR
- Typically expensive (not suited to smaller projects)
  - Image timing controlled by provider (if external)
  - Specific flight approval can be required
  - Operations susceptible to weather
  - Aircraft availability may be limited in remote regions

- Cost-effective (suitable for smaller projects)
  - Imagery can be acquired on demand
  - Very high-resolution (fixed-wing: 2.5 cm/pixel, rotary: sub-millimetre)
  - Typically unaffected by cloud cover (due to lower flight altitudes)
  - Excellent positional accuracy with GCPs or RTK
- Relatively small single-flight coverage
  - Drone regulations or bans can restrict usage
  - Operations susceptible to bad weather
  - No canopy penetration (unless heavy LiDAR payload)
  - Difficult to reconstruct imagery with few tie points (for example, imagery of homogenous terrain or water)

- Excellent positional accuracy
  - Just the data required (no data overload)
  - Very high resolution
  - On the go data classification (vector/meta-data)
- Slow, labour-intensive collection
  - Equipment can be expensive (e.g. laser scanner)
  - Line-of-sight issues
  - Difficult to record tops of features
  - Some sites inaccessible on foot
  - Limited graphical outputs (depending upon equipment)
Why use UAV’s for Transportation Projects?

1. High Precision UAV mapping accuracy is similar to GPS

2. Worker Safety & Labor spent mapping using a UAV is considerably lower than GPS Surveying

3. Photographic Data – Quality Assured
County Demonstration Project Scope

- Utilize UAV technology in case studies at various locations through Washington State.
- Investigate & Evaluate the UAV’s capabilities and effectiveness in improving Mapping and Reducing Mapping/Inspection costs.
- UAV technologies were investigated to evaluate their capabilities as they relate to county road and bridge projects.
Today’s Transportation Inspection & Surveying Tools....
### Two Types of UAV: Fixed-wing vs Rotorcraft

<table>
<thead>
<tr>
<th>Feature</th>
<th>Large Areas</th>
<th>Small Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coverage</td>
<td>Large Areas</td>
<td>Small Areas</td>
</tr>
<tr>
<td>Takeoff &amp; landing</td>
<td>Linear</td>
<td>Spot</td>
</tr>
<tr>
<td>Object resolution</td>
<td>Inch/pixel</td>
<td>mm/pixel</td>
</tr>
<tr>
<td>Oblique Imagery</td>
<td>0° to -50°</td>
<td>+90° to -90°</td>
</tr>
<tr>
<td>3D Mapping of Infrastructure</td>
<td>Difficult</td>
<td>Much easier</td>
</tr>
<tr>
<td>Close-up Inspection</td>
<td>Not adapted</td>
<td>Well adapted</td>
</tr>
</tbody>
</table>
Each UAV Type Produces Geo-referenced orthomosaics, Digital Surface Models, and Point Clouds
Example of Fixed Winged UAV’s
The UAV is good to go for launch -

Phyllis Kanyer, Kitsap County Surveyor
THIS IS A COMPOSIT OF THE PHOTOS TAKEN DURING THE FLIGHT.

129 PHOTOS WERE TAKEN, ONLY 124 WERE USED DUE TO THE EAGLE.
THE SOFTWARE CONVERTS THE PHOTOS INTO A DIGITAL SURFACE MODEL.

STOCK PILES CAN BE SELECTED AND VOLUMNS CALCULATED.
Photographic rich data seamlessly imported into a design System CAD program for surface creation.
Design System Software

- Point Cloud Creation
- Surface Creation
Stockpile Surface Quality Comparison and Volumes

**Field Demo Results:**
- Flight distance: > 2.6 Miles
- Land area mapped: > 30 acres
- Total flight time: 9 minutes

**Conventional Survey Surface:**
Volume = 4,236 C.Y.

**UAV Surface:**
Volume = 3,838 C.Y.
Types of Rotorcraft UAV’s
3 typical applications
Bridge inspection
Bridge inspection: Arch Condition Rating
Bridge inspection: Girder rebar
Bridge inspection: piers
Bridge Pier – Mapping Cracks
Cracks detection and monitoring
Rock Face Inspection's

- 15 minutes flight
- 36 ft distance from cliff
- 0.01 Ft. or 0.3 cm / pixel.

- Cracks & potential rockfalls clearly visible (useful for volume / mass estimation & reinforcement planning)
Truss Bridge inspection:
Bridge inspection: Substructure difficult to Access.
Bridge inspection: Use of InfraRed Payload
INFRASTRUCTURE ARCHIVE MODELING
Congress Tells FAA to Get Busy

License Timeline

- **February 3, 2012** – Incorporate UAS ops safely into the NAS system without being a huge burden on the owners/operators, which they are obligated by congress to do so, in the [Airspace Modernization Act of 2012](https://www.congress.gov/112/plaws/statute/2012).  
- **March 7, 2012** – Issued notice it was looking for 6 test sites  
- **May 14, 2012** – Public Safety can fly up to 25 lbs. UAV’s without license:  
  - UAS must be flown within the LOS (line of sight) of the operator,  
  - less than 400 feet above the ground,  
  - during daylight conditions, and  
  - inside Class G (uncontrolled) airspace and more than five miles from any airport or other location with aviation activities.  

*Current FAA regulation 333 Exemption is the only current system for commercial UAS compliance*.

Until FAA Part 107 rules proposed for 2016...
What’s different about Part 107 from Section 333?

- No need for previously licensed FAA pilot as operator.
- An extra VO (Visual Observer) is not required for flights.
- No need for Air Traffic Control clearance in class G airspace.

*This is a big deal!*
In conclusion, UAV Technology in transportation projects:

1. When compared to conventional aircraft, because a UAV is easier, safer, and more efficient.

2. High Precision UAV mapping accuracy is comparable to GPS accuracy.