Drone Presentation & Demonstration

National Association of County Engineers
Conference
April 23rd 2018

JOE CAMPBELL, P.E., M.S.C.E.
Area Engineer/Assistant Division Bridge Engineer
Topics that will be covered

- Technology Transfer (T2) award
- FAA Part 107 Rule and MnDOT Aeronautics Registration
- Drones as bridge inspection tool
- Goggles Inspection “A Game Changer!”
- Demonstration of drone and goggle capability
- Costs – drone, goggles, batteries, insurance and other
Local Program Agency/State Aid - Drone Bridge Inspection

- Built from the combination of my background in bridge design, bridge inspection program administrator and FHWA assistant division bridge engineer
- FHWA bridge inspection tool, MnDOT Phase I finding
- FAA part 107 Rule

Received T2 fund award

- Purchase a drone
- Share the findings of how off the shelf drone products meet the primary needs for routine bridge inspections
- Presentation and demonstration of drone and peripherals.
FAA Rule Governing Drone Use
Government and Commercial Use

FAA link [https://www.faa.gov/uas/](https://www.faa.gov/uas/)
To operate the controls of a small unmanned aircraft system (UAS) under Part 107, you need a remote pilot airman certificate with a small UAS rating, or be under the direct supervision of a person who holds such a certificate.

You must be at least 16 years old to qualify for a remote pilot certificate, and you can obtain it in one of two ways:

- You may pass an initial aeronautical knowledge test at an FAA-approved knowledge testing center.
- If you already have a Part 61 pilot certificate, other than a student pilot certificate, you must have completed a flight review in the previous 24 months and you must take a small UAS online training course provided by the FAA.
Part 107 - Operating Requirements

- The small UAS operator manipulating the controls of a drone should always avoid manned aircraft and never operate in a careless or reckless manner. You must keep your drone within sight.
- The maximum allowable altitude is 400 feet above the ground, and higher if your drone remains within 400 feet of a structure. The maximum speed is 100 mph (87 knots).
- You can’t fly a small UAS over anyone who is not directly participating in the operation, not under a covered structure, or not inside a covered stationary vehicle. No operations from a moving vehicle are allowed unless you are flying over a sparsely populated area.
- Operations of UAS in Class G air space.
Beginning April 16, the FAA also will consider agreements with additional entities to provide LAANC services. Currently, there are four providers—AirMap, Project Wing, Rockwell Collins and Skyward.

- All drones that would be used for bridge inspection have gps
- Current flight apps have safeties that limit some flight, airports, jails, etc
- FAA app will clarify flight restrictions and give flexibility to remote airman
- FAA app will allow for simplified flight approvals when needed
MnDOT Aviation

http://www.dot.state.mn.us/aero/drones/

- Drone Registration – MN registration is yearly, fee waived for Government Entities
- Proof of Insurance – provided yearly
- Airport Contact information – Yearly Airport Directory on Aeronautics web page

SECRETARY IN THE NEWS

- Trump Signs Executive Order Allowing States To Expand Drone Tests
- President Trump signed an executive order allowing states and local governments to apply for waivers with the FAA that would allow for the creation of pilot programs for an expanded range of drone testing, including long-distance flights, night flights, and flights over populated areas.
Bridge Drone Flight Under Part 107

Drone flight example meeting FAA part 107 rules not above traffic or pedestrian
Bridge Drone Flight
Under Part 107
WASHINGTON COUNTY

• Secured Aviation Insurance Policy Unmanned Aircraft Systems through Aviation Risk Consulting Inc.

• They obtained through a broker with Minnesota County Insurance Trust (MCIT), Mark Lentz from Bearance Mgmt Group.

Note:
League of Minnesota Cities – Information Memo
Drones: Municipal Use and Regulation
III City users of drones
  A. City employees as UAS pilots
3. State insurance requirements
...If a city has liability insurance through the League of Minnesota Cities Insurance Trust, the ... Minnesota Department of Transportation (MnDOT) ... city users are not required to pay the registration fee, but must register and provide proof of insurance.

Link to MN League of Cities Memo
https://www.lmc.org/media/document/1/dronesmunicipaluseandregulation.pdf?inline=true
Commercial Drones for Bridge Inspection
Recreational Drones for Bridge Inspection
Drones Around $1000
Fall 2016

GoPro Karma
DJI Phantom
DJI Mavic
Yuneec Typhoon
Consumer Drone Bridge Inspection

Drone 1

- 12 MP Camera for still photos (1/2” sensor)
- 4K video
- Camera gimbal range
  - 90 degrees down
  - 30 degrees up
  - 30 degrees left/right
- Collision avoidance/sensing
  - Forward – collision
  - Downward - sensing
- Crash Insurance
Consumer Drone Bridge Inspection

Drone 2+ (with built in remote display)

- Built in remote display
- 20 MP Camera for still photos (1” sensor)
- 4K video
- Camera gimbal range
  - 90 degrees down
  - 30 degrees up
  - 30 degrees left/right
- Collision avoidance/sensing
  - Forward - collision
  - Downward - sensing
  - Rear - collision
  - Right - sensing
  - Left - sensing
- Crash Insurance
# T2 - Drone Cost Breakdown

## Basic Bridge Inspection Drone & Peripherals

<table>
<thead>
<tr>
<th>Items</th>
<th>Drone 1</th>
<th>Drone 2+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drone + batteries +</td>
<td>$1,300</td>
<td>$1,900</td>
</tr>
<tr>
<td>Propeller Cages/guards</td>
<td>$150 cages</td>
<td>$50 guards</td>
</tr>
<tr>
<td>Case</td>
<td>$150</td>
<td>$250</td>
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<tr>
<td>Drone crash Insurance + replacements (1yr)</td>
<td>$300</td>
<td>$380</td>
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<tr>
<td>Tablet for Control</td>
<td>$400</td>
<td>Included</td>
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<tr>
<td>Equipment Costs</td>
<td>$2,350</td>
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Bridge Inspection Photos

Typical Pier Cap Photos

Drone Pier Cap Photos
Bridge Inspection Photos
Underside of Deck Inspection w/+30 Deg. Camera

Pictures from Drone with 30 Deg. Camera
Inspector Perspective
Pilot and Inspector

Inspector View from Drone Camera

Drone Pilot Direct Line of Sight
Inspector/Drone Perspective
Drone Inspection Next Evolution
First Person Vision (FPV) Goggles
• MN Division office discussion on peripherals by Drone manufacturer could be applicable to our T2 topic
• After discussion on the how the goggle peripherals look to improve the use of drone for bridge inspections.
• MN Division office Submitted for additional T2 funds to purchase goggles
High Definition - FPV Goggles

First Person Vision is not Virtual Reality

- **Virtual Reality**
  - Images are computer generated
  - Images viewer sees are not real, they are generated inside a computer, augmented reality

- **First Person Vision**
  - Images are real
  - Real time images transferred to viewer
  - Viewers perspective is that of the drones
High Definition - FPV Goggles
Drone with FPV Goggles Camera and Gimbal

- Video live feed to FPV Goggles
  - HD video feed 1080p/30fps
  - HD video screen 3840 by 1080 resolution
  - Low Latency 110ms
  - Vision 85 Deg field of view with 18 ft screen 9 ft

- Goggle Control
  - Head Tracking Gimbal control camera angle
  - Medea Control - Switch between camera and video recorder
  - Photo or video capture from touch pad

- FPV Goggles are “a game changer” for commercial drone use specifically in bridge inspections
Drone + FPV Goggles

What does that do for Bridge Inspection?

- Greatly improves the inspection
  - Allows the inspector to focus on inspection of components not worrying about falling off ladder or if drivers will pay attention to traffic control
  - Improves the quality of documentation of access restricted components

- Allows Inspectors to see at a equivalent distance of 3 feet
  - Drone can get within 6 feet of most standard bridge components, the use of a 2X optical zoom gives the FPV image to the inspector that is the equivalent of standing 3 ft away from component.

- Give the inspection team easy access to bridge components
  - No need for Ladders, Snoopers, Climbing equipment, etc.

- Greatly reduces the opportunities for slips, trips and falls
  - Eliminates crews carrying ladders down steep slopes
  - Eliminates need for inspection crew members to climb ladder to see that bearings and such are in good shape
Main Topics Covered

- FAA Part 107 Rule and MnDOT Aeronautics Registration
- Drones as bridge inspection tool
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2018 County use for routine Bridge inspections

- Polk, Renville, possibly Chippewa
- St. Louis has used drone during routine inspection March 2018
St Louis County MN
Drone Bridge Inspection

Chris Grahek, St Louis County Bridge Inspector
First Drone use March 22\textsuperscript{nd}, 2018.
Livestream via YouTube Live

https://www.youtube.com/channel/UCYPEiI2YKNgWvrgJHSfz3Sg
• Other uses
  o Livestream to Facebook Live, YouTube Live, others
  o Videos/Livestream for public meetings
  o Videos for construction update
  o Video and Photos for Preliminary Design and Construction inspection
  o Emergency response
  o ??? Endless possibilities.
Other County Interests

• **Work Safety**
  - Removes some slip, trips and falls opportunity

• **Technician**
  - Improves work opportunities
  - Improves employee retention
### Cost Recap & Questions

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Joe Campbell, Joe.w.Campbell@dot.gov, 651-291-6121

**FAA and MnDOT Aviation Links**

- FAA primary Drone/UAS site: [https://www.faa.gov/uas/](https://www.faa.gov/uas/)
- MnDOT Aviation Drone: [http://www.dot.state.mn.us/aero/drones/](http://www.dot.state.mn.us/aero/drones/)