Use of UAS in Transportation Operations

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October 17, 2018
Disclaimer

The materials in this presentation discuss general procedures about the use of UAS / Drones and don’t represent procedures and policies of the New Jersey Department of Transportation.
We sincerely acknowledge the support of NJDOT in sponsoring the research on “Drone/Unmanned Aircraft System (UAS) Regulations and Policies for Use in New Jersey”. We are very grateful for the support of Mr. Glenn Stott and Ms. Stefanie Potapa during the conduct of this research.
UAS/UAV/DRONE DEFINITION:

NJ Stat § 2C:40-27:

- An unmanned aircraft means an aircraft that is operated without the possibility of direct human intervention from within or on the aircraft.

- Unmanned aircraft system (UAS) means an unmanned aircraft and associated elements, including communication links and the components that control the unmanned aircraft, that are required for the pilot in command to operate safely and efficiently.

- Consistent with FAA definition of UAS.
Small Unmanned Aircraft Vehicle
Why Use UAS?

- They can be deployed on demand.
- They have flexibility in tasking: e.g., surveillance, disasters,
- They have “plug and play” capabilities for their payloads, making tailored systems possible.
- They can support high-resolution imagery or sensors.
- They can cover remote areas
- They can be designed to access areas generally inaccessible by human inspectors.
- They can be used to transport small payloads.
CHALLENGES IN BRIDGE INSPECTION USING UAS
USE OF UAS BY TRANSPORTATION AGENCIES

UAS Operations

Recreational Use
- Commercial
- Law Enforcement

Non-Recreational Use
- Public Agency
  - Emergency Operations
    - Pre-Hazard Monitoring
    - Post-Hazard Monitoring
    - Emergency Management
  - Non-Emergency Operations
    - Aeronautics
    - Planning Survey
    - Maritime
    - Others
    - Physical Infrastructure Inspections
    - Environmental Survey
    - Construction Inspections
    - Traffic Management
<table>
<thead>
<tr>
<th>UAS Operations in Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bridge Inspection</td>
</tr>
<tr>
<td>3. Traffic Management</td>
</tr>
<tr>
<td>5. Emergency management</td>
</tr>
<tr>
<td>9. Check for flooding post storm or drainage issues pre storm</td>
</tr>
<tr>
<td>15. Drainage outfall inspections.</td>
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<tr>
<td>17. Inspection or Drainage outfalls.</td>
</tr>
<tr>
<td>19. Assisting in installation mark outs (for signs, etc.)</td>
</tr>
<tr>
<td>21. Observing traffic back-ups and queue lengths behind highway incidents</td>
</tr>
<tr>
<td>25. Observing queue lengths to provide a qualitative assessment of congested interchanges.</td>
</tr>
<tr>
<td>27. Record intersections with high volumes and turning movements to really understand what's happening at difficult locations.</td>
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<tr>
<td>29. Post-disaster inspections of hard-to-reach areas and facilities</td>
</tr>
<tr>
<td>31. Photography/video for reports and studies/aerial cityscape videos and pictures</td>
</tr>
<tr>
<td>33. Real-time construction project updates</td>
</tr>
<tr>
<td>35. Scoping out potential rights-of-way</td>
</tr>
<tr>
<td>37. Surveys for determining transit station center points or location of development footprints inside or outside of a Transit Village</td>
</tr>
</tbody>
</table>
Bridge Inspection by UAS

Key Advantages

- High resolution photogrammetry
- Ease of access
- Inspection using tools such as Infrared cameras
- Possibility of automated crack mapping using complex algorithm
- Automated bridge inspection report generation
- Rapid post-hazard assessment, such as inspection during hurricanes

Challenges

- Hands on inspection
- Direct use of NDE technology
- Under deck inspection
CURRENT NEW JERSEY REGULATIONS APPLICABLE TO UAS

- NJ Stat § 2C:18-3 (Trespassing)
- NJ Stat § 2C:14-9 (Invasion of Privacy)
  - NJ Stat § 2C:40-27 (Definitions relative to operation of unmanned aircraft systems)
  - NJ Stat § 2C:40-28 (Violations, degree of offense, crime)
  - NJ Stat § 2C:40-29 (Provisions preempt existing laws)
  - NJ Stat § 2C:40-30 (Authorized use permitted)
- NJAC 7:25-5.22 (Wild animals; possession, killing)
PART 107 REGULATIONS ON DRONE OPERATION

- Unmanned aircraft must weigh less than 55 lbs. (25 kg).
- Visual line-of-sight (VLOS) of RIPC or VO only.
- Maximum altitude of 400 feet above ground level (AGL).
- Minimum weather visibility of 3 miles from control station.
- UAS may not operate over any persons not directly participating in the operation.
- Daylight-only operations, or civil twilight.
- Must yield right of way to other aircraft.
PART 107 REGULATIONS ON DRONE OPERATION

- May use visual observer (VO)
- Maximum groundspeed of 100 mph (87 knots)
- 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 aircraft.
- No operations from a moving vehicle unless the operation is over a sparsely populated area.
- No carriage of hazardous materials.
UAS OPERATIONS CONCERNS IN TRANSPORTATION

- Privacy and Data Management
  - Privacy invasion
  - Data collection and storage policy

- Safety Management System
  - Risk assessment
  - Risk mitigation
  - Safety assurance

- Qualification and Training
  - Qualification tracking
  - Periodical training

- Operational Requirement and Control
PRIVACY AND DATA MANAGEMENT

▪ Consent
  o Flying over private properties
  o Emergency situations

▪ Data Collection
  o Identifiable feature
  o Specific to mission purpose

▪ Data Management
  o Open Public Records Act (OPRA)
  o Acceptable Use of Data policy of New Jersey
  o Destruction of Public Records Act, N.J.S.A. 47:3-15
Critical Infrastructures

- Definition of Critical Infrastructures
- Federal definition per 2339D of Title 18, United States Code
- Local definition

- Examples:
  - Gas and oil production, storage, or delivery systems
  - Water supply systems
  - Telecommunications networks
  - Electrical power generation or delivery systems
  - Financing and banking systems
  - Emergency services (medical, police, fire, and rescue services)
  - Transportation systems and services (highways, mass transit, airlines, and airports)
Potential Risks during UAS / Drone Operations

Diagram showing potential risks during UAS/Drone operations, categorized into primary accidents, secondary accidents, and falling debris, leading to consequences such as injury or fatality, damage to property, impact on society, damage/loss of system, and impact on environment.
SAFETY MANAGEMENT SYSTEM

Risk Management Procedure (RMP)

- Hazards Identification
- Risk Assessment
- Risk Mitigation

Hazards

- Weather
- Terrain / Obstacles
- Multiple UAS operations
- Crew Fatigue
- Complex High Density Airspace
- UAS Engine Failure
- Lost Link Event
## RISK ASSESSMENT

### Likelihood

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Detail</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
<td>Likely to occur many times or has occurred frequently (&quot;five times during operation&quot;)</td>
<td>A</td>
</tr>
<tr>
<td>Occasional</td>
<td>Likely to occur many times or has occurred frequently (&quot;Every second operation&quot;)</td>
<td>B</td>
</tr>
<tr>
<td>Remote</td>
<td>Unlikely to occur, but possible or has occurred rarely (&quot;I know it from some events&quot;)</td>
<td>C</td>
</tr>
<tr>
<td>Improbable</td>
<td>Very unlikely to occur or not known to have occurred (&quot;it happened once and I heard about it from other operator&quot;)</td>
<td>D</td>
</tr>
<tr>
<td>Extremely improbable</td>
<td>Almost inconceivable that the event will occur (&quot;never happened&quot;)</td>
<td>E</td>
</tr>
</tbody>
</table>

### Severity

<table>
<thead>
<tr>
<th>Severity</th>
<th>Customized Detail</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated</td>
<td>Serious injury or death to people; Drone, equipment or buildings destroyed</td>
<td>IV</td>
</tr>
<tr>
<td>Moderate</td>
<td>Injury to persons; Further operation not possible without major adjustments</td>
<td>III</td>
</tr>
<tr>
<td>Marginal</td>
<td>Minor incident to persons; Minor effect on system performance</td>
<td>II</td>
</tr>
<tr>
<td>Negligible</td>
<td>No injury to persons; Minor consequences on system</td>
<td>I</td>
</tr>
</tbody>
</table>
## RISK ASSESSMENT MATRIX

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Severity</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negligible (IV)</td>
<td>Marginal (III)</td>
</tr>
<tr>
<td>Frequent A</td>
<td>Blue</td>
<td>Yellow</td>
</tr>
<tr>
<td>Probable B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occasional C</td>
<td>Light Green</td>
<td>Blue</td>
</tr>
<tr>
<td>Remote D</td>
<td>Green</td>
<td>Medium 2</td>
</tr>
<tr>
<td>Improbable E</td>
<td>Low 1</td>
<td></td>
</tr>
</tbody>
</table>
MITIGATION

- Weather
  - Semi-annual training
  - WX mitigation policies in flight operation manual
  - Standard Operating Procedures

- Terrain / Obstacles
  - Site Survey
  - Obstacle Map / Drawing

- Multiple UAS operations
  - Marked A/C Operation areas
  - Use of visual observers
  - Assumed Responsibility for Separating UAS from other air traffic
MITIGATION

- Crew Fatigue
  - Fatigue management program
  - Duty Day limitations
  - Rest requirements

- Complex High Density Airspace
  - Controlled / uncontrolled airspace
  - UAS Geo-Fencing
  - Standard Operating Procedures and training

- UAS Emergencies / Contingencies
  - Minimum Launch / alternate landing sites
  - Emergency brief by RPIC on every flight
  - Yearly open and closed book emergency procedures exam
# Risk Assessment Matrix

<table>
<thead>
<tr>
<th>Date</th>
<th>Mission/Flight Purpose</th>
<th>N-Number</th>
<th>UAS Type</th>
<th>NDOT Division</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>


**Mission #:** Frequency: Airspace Class

*Weather information will be obtained and provided for inspection before flight operations.*

Select an applicable item from the drop-down list and rate the total score below.

## Weather

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Score</th>
<th>Item</th>
<th>Value</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceiling (ft): Minimum 1000'</td>
<td></td>
<td></td>
<td>Launch/Recovery Site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visibility (SM): Minimum 3 miles</td>
<td></td>
<td></td>
<td>Operations Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winds (KTS): +15 Knots</td>
<td></td>
<td></td>
<td>Population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rain/Snow</td>
<td></td>
<td></td>
<td>Complex Airspace</td>
<td>Traffic</td>
<td></td>
</tr>
<tr>
<td>Thunderstorms</td>
<td>None</td>
<td>1</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Level Wind/Shear Within 10mi</td>
<td></td>
<td></td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature (Degrees F)</td>
<td></td>
<td></td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Density Altitude (ft)</td>
<td>0-1500</td>
<td>1</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Flights are not authorized when T-storms and/or lightning are observed within 3 mi of operations area.*

## Crew Experience

<table>
<thead>
<tr>
<th>Crew Experience</th>
<th>Value</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFC Experience</td>
<td>Experienced</td>
<td></td>
</tr>
<tr>
<td>Crew Current (days)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Mission Frequency</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Crew Resilience Day

<table>
<thead>
<tr>
<th>Crew Resilience Day</th>
<th>Value</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of Rest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of Duty Day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flight Sickness</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Mission

<table>
<thead>
<tr>
<th>Mission</th>
<th>Value</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Equipment/Aircraft

<table>
<thead>
<tr>
<th>Equipment/Aircraft</th>
<th>Value</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Any factor rating 3 or higher, adequate control measures must be documented and provided to supervisor.
QUALIFICATION AND TRAINING

FAA General Requirements:
- Minimum 16 years old
- English reading, speaking and listening skills
- Medical condition to safely operate a small UAS
- Passing aeronautical knowledge exam (every two years)

Potential Specific Training Requirements:
- Phase 1
  - FAA Remote PIC Certification
- Phase 2
  - Practical training including weather condition check, preflight checklist, inspection, mission brief, landing, camera control, log book, taking photos, hands on flight maneuvers
- Phase 3
  - Mission Specific / Solo, includes practice flight
OPERATIONAL REQUIRMEMT AND CONTROL

- Operations near Aeronautical Facilities
- Crew Members Effective Communication
- Temporary Flight Restrictions
- Mission Planning
  - MISSION-GENERAL
  - MISSION-SPECIFIC
  - SAFETY PROTOCOLS
  - EMERGENCIES
  - OPERATIONAL REQUIREMENTS
  - MISSION DEBRIEF
- Launch and Recovery Sites Selection
CONCLUSIONS

- Operation of UAS / drones for infrastructure inspection quite complex and requires detailed procedures on safety, security and data management.

- Still numerous challenges in successful application of the technology for inspection of bridges.

- Allows for rapid assessment / monitoring of large number of transportation operations.

- UAS / drones procedures for NJDOT currently in progress and is expected to be available by May 2019.