Unmanned Aircraft Transmission Line Maintenance Technology

RMEL’s Transmission Planning and Operations Conference
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Ft. Collins, CO - Solutions Provider
www.uav-recon.com
Specializing in Electrical Infrastructure & Aerial Thermography
Agenda

- sUAS Trending Services
- Aerial Thermography
- Case Studies
- sUAS Overview (Optional)
- Q&A
sUAS Trending

▶ Maintenance Services

sUAS - Drone - UAS - Unmanned Aircraft - Bird - Ship
Trending Service’s for “Maintenance Optimization”

- Maintenance Inspections
  - Up Pole
  - Components & Hardware
  - Aerial Thermography
- Structure Locating for GIS
- Structure Inventorying
- Rapid Damage Assessment
- Condition & Maintenance Documentation
- RoW Management
  - Vegetation Mapping
  - 2D & 3D Maps
  - LIDAR
  - Topo Contour Maps
  - Risk Assessment Models
3 Types of External sUAS Business Models

Equipment Sales & Service
- Drones, Software, Training
- Distributor - No Flight Op’s
- Repairs & Service Work

Service Provider
- Equipment Owner
- Flight Operations
- ‘Generalist’

Solution Provider
- Service Provider +
- Technical Analysis
- Data Management
- ‘Specialist’
In-House Business Model

Utility is responsible for entire sUAS program, operations, and final product.

<table>
<thead>
<tr>
<th>Sample Checklist</th>
<th>Budget Impact</th>
<th>Budget</th>
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<tbody>
<tr>
<td>Multiple Aircraft</td>
<td>*Fixed</td>
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<tr>
<td>Charging System &amp; Equipment</td>
<td>*Fixed</td>
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<tr>
<td>Field Tech - Laptop Computer &amp; Mobile Tablet</td>
<td>Fixed/Annual</td>
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<tr>
<td>Office Tech - Desktop Computer &amp; Server</td>
<td>*Fixed</td>
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<tr>
<td>Pre-Flight Software</td>
<td>*Fixed/Annual</td>
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<tr>
<td>Post-Flight Software</td>
<td>*Fixed/Annual</td>
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<td>Insurance - Aircraft &amp; General Liability</td>
<td>Annual</td>
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<td>Software &amp; Hardware Training</td>
<td>Fixed</td>
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<td>Transportation</td>
<td>Annual</td>
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<tr>
<td>Personnel - Flight Ops &amp; Data Management</td>
<td>Annual</td>
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<td>Personnel - Management</td>
<td>Annual</td>
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<td>Per Deim, Travel, Project Costs</td>
<td>Annual</td>
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- Coverage Rate
- Cost / ROI
- Scope of Ops

* Flight Operations Dependent
Visual Inspection Data Types

Photos or Video

- (1) structure of ~ 25 photos (175MB)
- (1) structure of 3:00 Minute Video (1GB)
- Data based on previous slide
  - 75 Miles; 24,270 Images; 1,005 Structures; 160GB of Image Data

- Photos are easier to file, search, markup, share, and analyze
- Videos offer significantly higher amounts of data recording
- Extracting stills from video isn’t efficient
- Data sizes will vary due to market available sensor options
Stitched & Processed Data

- 3D Point Cloud
- 2D Orthomosaic
- LIDAR

[Image of 3D Point Cloud]
[Image of 2D Orthomosaic]
[Image of LIDAR]

https://vimeo.com/236642814
http://134.249.136.27/demo/uav.01/#14/40.8595/-99.5880
http://134.249.136.27/demo/uav.01/#14/40.8595/-99.5880
Understanding Capabilities & Limitations

**Tool** - a device or implement, used to carry out a particular function; or to be equipped to carry out a particular function or process.  
*Not all tools are alike!*
Thermography Accuracy Factors

Why is 'Span' important?

<table>
<thead>
<tr>
<th>Span</th>
<th>Spot Size Ratio</th>
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<tbody>
<tr>
<td>45</td>
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<tr>
<td>40</td>
<td>43</td>
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<td>-30</td>
<td>26</td>
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<td>-40</td>
<td>24</td>
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Smaller Span = Finer Detail

Spot Size Ratio =
Ground Vs Air - View Comparison (Video)

https://www.youtube.com/watch?v=CmdqesPWsQY&feature=youtu.be
How is Aerial Thermography Different

Substation & Line Inspections

- Smaller Span
- SSR Angle - More Accurate
- Physically Safer
- Visual + Thermal
- Patrol Faster +(10) mph vs ground based

*based on default camera settings
Missed during nighttime
ground thermographer
(3) Case Studies
Rapid Response - Outage & Damage Patrol

- 69kV Loop Circuit - Ground Patrolled 2x
- (1) Pilot Flew ~90 structures, 400 Photos / 2GB Data
- Issue Identified via sUAS, confirmed by Bucket Truck
  - Utility Cost to Patrol - $1,680 (3) day
  - sUAS Cost to Patrol - $1,500 (1) day

Plan a sUAS Response Integration

By planning ahead of time, sUAS operators can have pre-programed travel routes; grid understanding, and faster in-field coverage.
By using sUAS & maintenance optimization strategies, utilities can budget condition-based repairs and prioritize maintenance on distinct identified structures, vs percentage of grid, resulting in more ‘critical repairs’ completed per year, which meet traditional maintenance minimums.
Substation Thermography

- **Ground Based Method**
  - ~ $100/sub; 30 minutes per site, Nighttime only
  - (1) thermal advisory
  - ~(1.5) total man hrs including report & analysis

- **Aerial Thermography Method**
  - ~$800/sub; Nighttime + Daytime (2 hrs total)
  - (9) thermal advisories; (2) visual advisories
  - ~(5) total man hrs including report & analysis
sUAS Overview
FAA - Laws & Regulations
Part 107 - Commercial Operation Guidelines

- Flights up to 400' AGL
- sUAS weight limited to less than 55 lbs
- Daylight Operations Only
- Pilot in Command (PIC) must maintain ‘Line of Sight’
- No operations over people or moving vehicles
- Can not operate from moving vehicle
- Class G only, Other airspace requires ATC approval
- Pilot can operate only 1 sUAS at a time
- FAA does not regulate Privacy or Data Acquisition
- Federal Regulation - Not State Regulated

*Most guidelines above have Waivers & Exceptions which permit legal operations outside of these parameters.*
sUAS Platform Categories

*Electrical & Industrial Applications

**Multi-Rotor**
- $5k - $40k
- DJI Matrice 100
- DJI Matrice 210
- AceCore NEO
- Intel Falcon 8
- Asset Inspection
- > 30 min flight time
- Multiple Payload Options
- Manual & Autonomous Flight

**Fixed Wing**
- $12k - $20k
- BAAM TECH Futura
- SenseFly Ebee
- Mapping & Photogrammetry
- Large Coverage Area
- < 45 min flight time
- Fully Autonomous Flight

**Advanced Operation**
- $50k +
- Aeryon SkyRanger
- Pulse Vapor
- Inspection & Mapping
- Secure Networks
- Extended flight times
- LIDAR & Complex Payloads
Q&A

Key Takeaways

• Pick the right tool for the job
• Multiple sUAS is preferred
• Find ‘Specialists’
• Start program with fastest ROI to gain buy in
• Leverage Volume
• Pick 2: Price - Speed - Quality
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