Intermediate Drone Ops: Expanding and Managing Your SAR Drone Program

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Review of our last class: Team Support

- Aerial search
 - Hasty
 - Detailed
- Reconnaissance
 - Patient status
 - Ingress/egress routes
 - Situational Awareness
- Ground team support



Review of our last class: IC Overwatch

- IC Situational Awareness
- Real time monitoring of operations remotely by IC.
- Ability to plan ahead.
- Coordinating separate teams



Review of our last class: Hazardous Terrain

- Cliffs
- Swiftwater
- Ice Rescue
- Avalanche Terrain
 - Searching dangerous terrain
 - Searching after an avalanche



Review of our last class: Requirements

- Regulations and personnel
- Equipment (AC and payloads)
- Training, SOPs, support needs
- Maintaining a program



Goals and Learning Outcomes

- Search management
- Crew Resource Management (CRM)
- Our ICS Organization Chart
- Drone Team Structure
- Training
- Asset Management
- Possible Field Session if there is interest...

Key Concept to Always Remember

Don't adapt your mission to your drone.

Adapt your drone operations to match the missions you actually have.

Searching Protocols

- Manual Flight: Hasty Search
 - Lost Person Behavior
 - LKP and Search Theory
 - Checking cell phone pings
- Manual Flight: Difficult Terrain
 - Cliffs
 - Swiftwater
 - Avalanche Terrain
- Manual Flight: Detailed or Targeted Grid
 - Sweeping surrounding areas
- Manual Flight: Grid
- Programmed Flight: Images for pixel analysis, e.g. Loc8



Crew Resource Management (CRM)

Defined as "A management system which makes optimum use of all available resources (equipment, procedures, and people) to promote safety and enhance the efficiency of flight operations."



Crew Resource Management (CRM)

Was originally termed Cockpit Resource Management, and was developed out of the Tenerife Airport crash in 1977 (two B747 collided on the runway which killed 583 people)

United Airlines was the first to use the system in a practical setting in 1981

CRM has been proven to work in many different industries outside of aviation

Crew Resource Management (CRM) Threat and Error Model





Crew Resource Management (CRM)



Swiss Cheese Model

In Practice for Aircraft

Crew Resource Management = CRM

- A protocol for environments where human error can have catastrophic results.
- Two-way communications
- Use all available skills
- Follow the SOPs
- Delegate flying to someone else while solving bigger problems
- Training mandated by the FAA for all commercial pilots.
- Mandated for all DoD air crews by the USAF and Naval Air Force.

CRM Management of Human Errors



CRM Skills & Environment



(Spelling and grammar errors in original.)

CRM: Management of Error Response



R. Helmreich, J. Wilhelm, James Klinect, A. Merritt (2001)

Integrating a Drone Team into a SAR Team

- ICS System
- Training with all teams
- Developing trust and communication
- Understanding that it is a support function
- Provide the AHJ a resource/asset
 - Live feed (can help PIO)
 - Documentation of effort by team
 - Videos showing off the team
- SARTopo or ATAK integration
 - APRS and ham radio
 - DroneSense



Weber County Sheriff's SAR ICS Org Chart



The Drone part of the overall org chart

Operations Section SAR Section Chief, SAR Deputy Chief



A similar example: This is a Boulder, CO, org chart.



WCSSAR Drone Team Structure

- Pilots
- VOs
- Ground support or Field Crew
 - Searchers
 - Batteries
 - Flight Operations Area (FOA) setup on arrival
 - FOA security
- Air Commander
 - Air space deconfliction, including helicopters
 - Liaison between IC, SAR team leads, and flight crew

Training

- Training logs
- SOPs
- Studying and training on each phase of flight
 - Preflight
 - Takeoff
 - Departure
 - On Mission
 - Approach
 - Landing
 - Post-flight



Training Advanced Flight Skills

- Night operations, especially flying with IR vision.
- Challenging weather conditions
- Navigating tight spaces and complex environments
- Searching difficult terrain such as dense forests or complex boulder fields
- Piloting in different modes, not just GPS. ("Attitude" mode for example.)
- Emergency landing SOPs in the backcountry. Especially doing it in a place where you can get a ground team to the drone.

NIST sUAS Training & Similar

- Flight patterns in all orientations
 - POI
 - Fly course/pattern with drone yaw at 0°, 90°, 180°, 270°
- NIST sUAS Open Test Lane
 - Controlled environment
 - Timed flight test
 - Forces flight in all orientations
 - Requires pilot to control flight AND camera



Training with All Available Equipment

- Zoom camera
- IR (search and night flight)
- Camera with gimbal
- Spotlights
 - Aligning spotlight with camera
- Mapping Integration (SARTopo, ATAK)
- Payload drops
- Speakers
- Lifeseeker
- Mission flight



Training: Joint Operations

- Integrate training with every team
 - Climb Team (MRA)
 - Dive and Sonar teams
 - Swiftwater Team
 - Snowmobile Team
 - Mounted Team
 - Motorized team
 - K9 Team
- In after action debriefings ask for feedback



Asset Management

- Usage logs (paper or digital)
- Batteries always charged? (Next slide)
 - Very hard on batteries = \$\$
 - Takes personnel time
- Where are the drones stored?
- Aircraft inspections and things like prop replacement
- Access to aircraft limited to authorized personnel
- Who maintains the flight support assets? (Trailer, generator...)

Batteries!

- Very expensive! This is an investment.
- Keeping at 100% shortens life
- Keep some at 100% and rotate stock
 - Charge batteries enroute and at ICP
- Have enough spares for continuous flight
 - If you match the AHJ flight hardware, you can borrow
- **Temperature**: storage, use, & charging
 - Ice chests work both ways
- AC generator to run battery charger(s).
 - Can overwhelm many generators!

Asset Management: Aircraft Controller Setup

- All remote controllers (RC) should match as much as possible
 - Mode 2
 - Programmable buttons constant
 - Programmable buttons similar on all platforms
 - No personalization of programmable buttons

Valuable Capabilities/Assets

- All weather drone. Check IP rating for dust and moisture
 - DJI M300 is IP45
 - DJI M30 and M350 are IP55
 - IP = Ingress Protection
 - Solid objects: 4=dirt grains >1mm. 5=Fine dust resistant
 - Water: 5=Jetting water (flying in the rain)
- Live feed over the Internet: DroneSense, AirData, etc.
- Ground support (next slide)
- Multiple drones (following slide)

Ground Support

- Drone Van
 - Live demo tonight
 - Tour right now if time
- Climb team trailer
- AC power for battery charging
- Place for pilots to warm up
- Headsets for drone team

Multiple Drones

- Simultaneous Searching
 - Small drone packed into field
 - Multiple drones
 - Deconfliction needed
 - Can be horizontal or vertical
- One stays on station with patient
 - Cycle out drones as batteries run down
 - Constant illumination
 - IC Situational Awareness
 - Reduces **pestering** of field teams
- One scouts egress routes
- Pilot in field with spare batteries and second controller for handoff to extend VLOS downrange.

- Power lines and RF Interference
 - Power lines
 - Cradle point
 - WiFi sources
 - Microwaves
- Battery life
 - Cold
 - High altitude
 - Heavy payloads
 - Power hungry payloads
 - Wind
- Spare batteries for all support hardware (RC, headsets, etc.)

Threat and Error Model

- Curious bystanders & flight team distractions
 - Team members "giving advice" or wanting updates
 - General public with questions
 - General public that hates drones
 - Family that want to suggest where to look
- Extreme weather (usually cold)
 - Flight controllers with touch screens: gloves are a problem!
 - Too bright to see screen
 - Escape from heat
 - Snow and rain
 - NOT aerobic: Must overdress for cold conditions

- Trees/foliage block both VLOS and RF signal
- WiFi signal strength and distance (2.4 GHz helps vs. 5 GHz)
- Maps on controllers need topo lines
 - Topo maps vs. street maps
 - Maps must be downloaded for offline use
- Need clear communications protocols for interaction with SAR teams.
- Search is hard when using a small screen especially if you are piloting
- Having a VO that does not lose VLOS nor get distracted ("Squirrel!!")

- Situational Awareness is a big load on the pilot
 - Aircraft motion and attitude
 - Ground teams
 - Obstacles
 - Flight conditions
 - Battery status (including spares)
 - Etc.
- Spatial Awareness
 - Obstacles
 - Where are you? What canyon is this???

• Weather

- Highly variable winds
- Rain and snow
- Cold air
- High altitude
- Updrafts, downdrafts, and rotaries
- Maintaining training currency both alone and with other teams.
- Operating with other air assets such as helicopters

Threat: Money & Fundraising

- Initial outlay
- Ongoing expenses
 - Upgrades/accessories
 - Software subscriptions (WiFi hotspots, AirData, Loc8, etc.)
 - Battery replacement
 - Repairs (crashes and just worn out)
 - Drone replacement from crash, loss, and age
- Expansion of program
 - Trailer/mobile command van/trailer
 - Large screen monitors and the interface needed.
 - Solar panels, generators, deep cycle LA batteries, inverters, power monitoring, etc.

Final Classroom Session is Next: Advanced Capabilities and Future Technologies

- Advanced CRM concepts
- Funding, Maintaining, and Expanding your program
- Data analysis using Loc8 and similar software
- Advanced features in DroneSense and Motorola Cape
- Beyond airborne drones
- Advanced Payloads: Lifeseeker, LIDAR, multispectral cameras
- Future Features: BLVOS, shallow graves, swarms, mesh networks, etc.
- Drones and ICAR, MRA, LE, FD, USFS Wildland Fire, etc.

Summary and Questions?

- CRM is critical to a successful team.
- Define where drones "fit" in your team.
- Define a drone team structure.
- Training and currency is critical.
- These are fragile and expensive assets manage them!

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