m:N Working Group Report Briefing

Personnel Selection, Roles, and Training for sUAS

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sUAS Working Group Overview

- Founded in 2021, the sUAS WG currently has approx. 80 members representing Government (NASA, FAA, DoD), Industry (manufacturers, developers, researchers, designers), and Academia
  - Quarterly meetings with ongoing speaker series
  - Each year we tackle different issues/challenges affecting sUAS in the NAS
  - For 2024 we wanted to identify and address the critical challenges in personnel selection, role definition, and training for m:N sUAS operations
    - Reviewed the current landscape of sUAS operations and automation
    - Spoke with those developing UAS programs
    - Identified gaps in training and cognitive load management
    - Provided recommendations for future training and personnel selection practices as part of our report; "**Personnel Selection, Roles, and Training for sUAS**"

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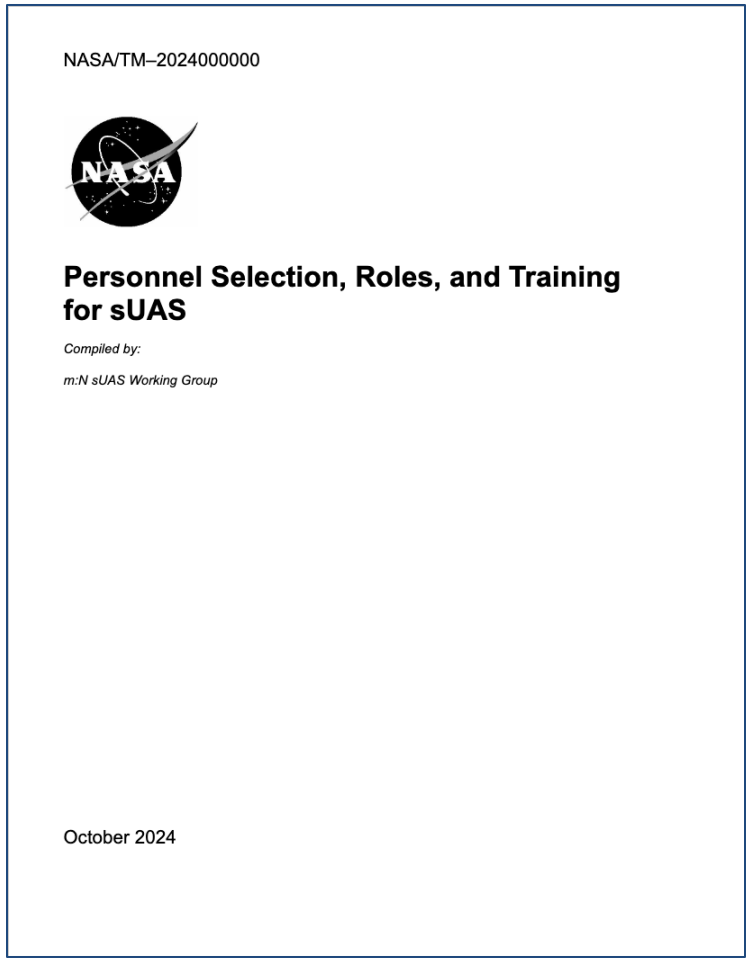
Report Contributors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Personnel Selection, Roles, and Training for sUAS

Compiled by:

m:N sUAS Working Group

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m:N WG Report Overview

- AAM overview and the significance of sUAS in modern operations
- Insights from use cases and case studies
- The challenges of managing multiple sUAS and the current training gaps
- The evolution of operator roles and the necessary skills for effective management of m:N operations
- Training requirements and fatigue management strategies for operators
- Future recommendations for personnel selection, training, and operational procedures

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Note that while the report details sUAS, many of the lessons learned can be applied to larger UAS as well.

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Why This Matters

There is an ongoing evolution for unmanned platforms, which have seen explosive advancements in capabilities and applications over the past two decades.

- Today, commercial UAS are used for package delivery in the U.S. and remote regions worldwide, delivering everything from food and supplies to life-saving medications
- There is large growth of Advanced Air Mobility (AAM) technologies, involving various aircraft types to enhance transportation capabilities for both cargo and passengers
- sUAS are seeing increased integration into urban infrastructures including to support emergency services and public safety
- Current conflicts such as in Ukraine illustrate how warfare is evolving with the proliferation of sUAS. Partly due to what we are seeing in Ukraine, the DoD is instantiating new programs that leverage advanced UAS capabilities

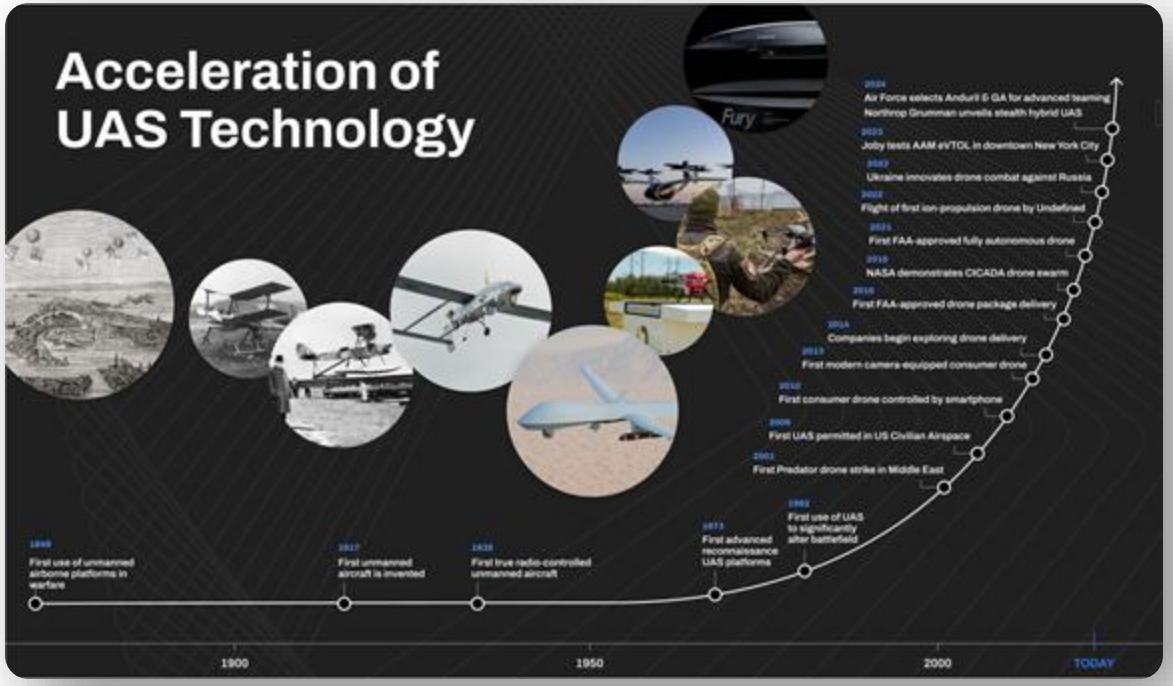

Image from HF Designworks

With this evolution comes deep ramifications on personnel roles, selection, and training with UAS.

Challenges in m:N sUAS Operations

The goal is m:N operations. However, managing multiple UAS presents significant challenges for operators:

- Operators must handle complex systems while **maintaining situational awareness**
- Current training, such as FAA Part 107, does not adequately prepare operators for **BVLOS or the management of multiple UAS**
- **Cognitive overload and fatigue** increase the risk of operational errors
  - The Yerkes-Dodson curve illustrates the relationship between cognitive load and performance

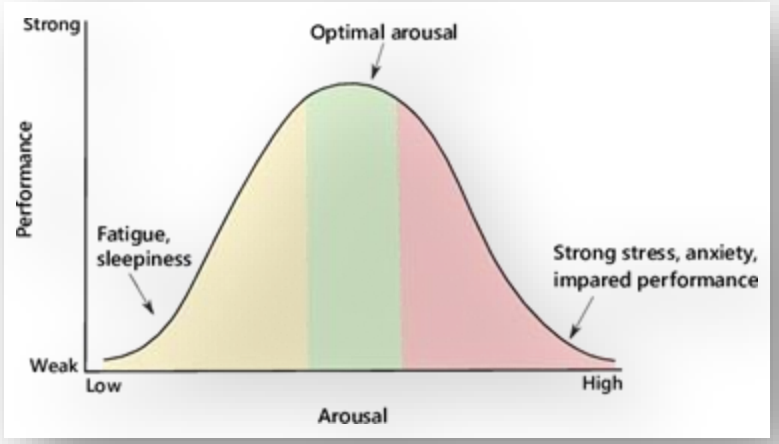

Image from ResearchGate

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Example Use Case: Framing the Challenge

Context: Drones-R-Us is contracted by CALFIRE to conduct fire surveys in Northern California using infrared sensors and AI analysis to detect hotspots and assess fire risk. Five operators each manage 10 small UAS, surveying designated areas effectively with automated planning tools to streamline operations.

Launch

Drones-R-Us launches 10 small UAS per operator to survey a designated area.

Event One

One UAS commanded by Operator 1 experiences a battery issue. The operator scrubs the mission, expedites the UAS's return to base, and redistributes tasks to the remaining drones to cover the area.

Event Two

A non-cooperative general aviation aircraft intrudes into two operators' survey areas. The ground-based DAA system alerts the operators, who reroute their UAS to loiter in safe zones.

Task Completion

After the airspace incursion is resolved, both operators coordinate to complete the remaining survey tasks, adjusting flight paths and mission timing to ensure full coverage.

This scenario illustrates the cognitive load on operators, **emphasizing the need for training in automated systems and decision-making under pressure**

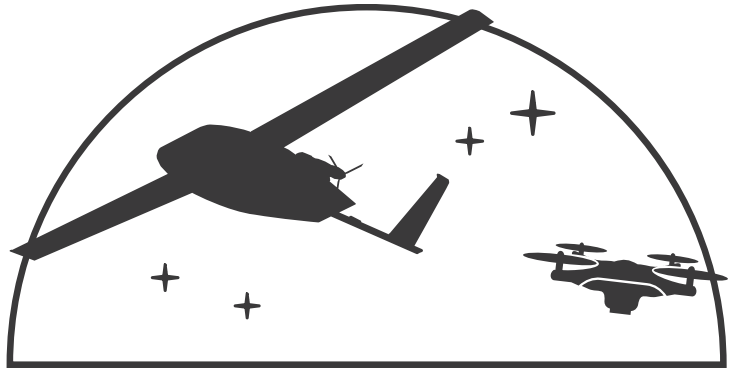
Case Study: Los Angeles Fire Department (LAFD)

LAFD uses drones to enhance SA and emergency response during firefighting operations

- The LAFD's sUAS training program **emphasizes coordination and SA** in high-stakes scenarios by training personnel to handle UAS in **dynamic environments** (e.g., wildfires, HAZMAT incidents, etc.)

- Three Certification Levels:
  - Level 1: Initial training on basic UAS skills and policies
  - Level 2: Intermediate training includes indoor and nighttime operations
  - Level 3: Advanced training covers payload operations and hazardous materials response

- LAFD assigns **distinct roles** (e.g., RPIC, VO, Property Officer, etc.) and responsibilities; reducing confusion during high-pressure operations



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Case Study: Denver Police Department

The Denver Police Department employs UAS to enhance public safety and improve incident response capabilities.

- Drones provide real-time aerial coverage for incidents, enabling officers to assess situations before arrival and allocate resources more effectively
- UAS reduce risks to officers by identifying potential hazards at crime scenes and during special events, ensuring safer operations
- UAS assist in locating missing persons and responding to emergencies, improving response times and effectiveness
- DPD mandates Part 107 certification and ongoing training for UAS operators, ensuring personnel are well-equipped to handle drone operations

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The Importance of Roles, Selection, and Training

- Defined roles are essential for **accountability and effective collaboration** among team members, such as operators and managers, **which is crucial for mission success**
  - Clear role definitions are critical in m:N UAS operations to prevent task confusion and overload:
    - Ensures all team members know their responsibilities, **reducing opportunities for error**
    - Clear roles allow operators to focus on key tasks, **reducing workload**
    - **E**nables **smooth communication and task delegation**
    - Well-defined roles also inform the hiring process, ensuring **personnel selection** with the specific skills necessary for each position

- Effective personnel selection ensures that candidates have necessary **technical skills and adaptability** for the job

- Robust training programs are vital for developing the knowledge, skills, and abilities (KSAs) needed to **manage complex operations safely and efficiently**

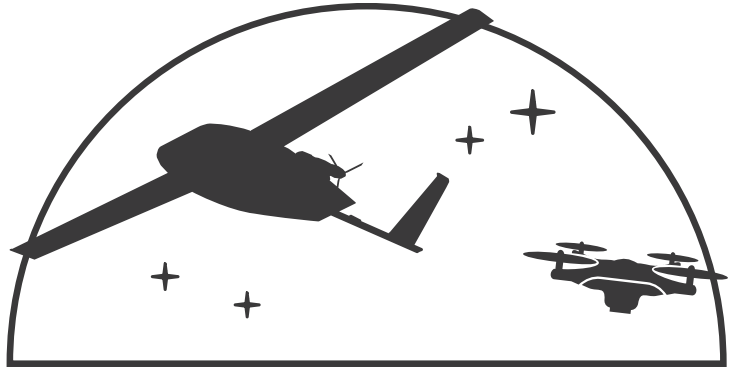
Operator Role Evolution in m:N Operations

The traditional role of a UAS "pilot" is evolving into that of a system supervisor

Operators will be managing integrated automation systems rather than controlling aircraft directly

- This transition requires new skills, including:
  - System monitoring
  - Automation management
  - Situational awareness
  - Cognitive load management
  - Decision-making

Traditional Pilot Skills	UAS Pilot Skills
Manual flight control	Automation management
Navigation, flight path planning	Managing multiple UAS
Monitoring surroundings for obstacles	Coordinating with team members and systems
Knowledge of emergency equipment and protocols	Decision-making based on system data and alerts



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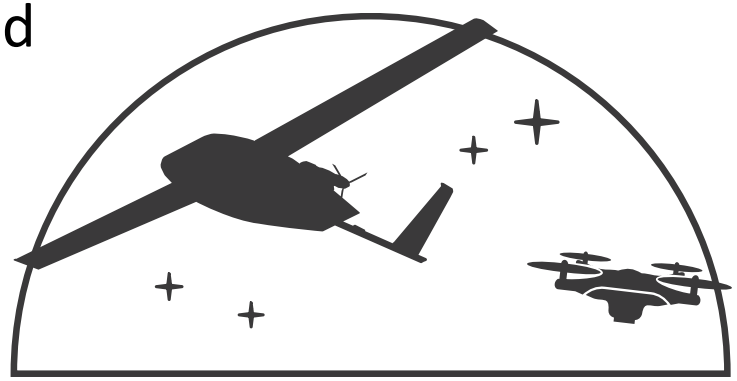
Personnel Selection for m:N Operations

Selecting the right personnel is essential for effective m:N operations

Selection Process:

- Cognitive ability and multitasking skills should be prioritized
- Experience in automation, gaming (especially fast-action games), or military UAS operations correlates with high performance
- Strong decision-making and problem-solving capabilities under pressure are critical

Candidates should have the ability to manage multiple automated systems simultaneously, and adapt quickly to changing scenarios



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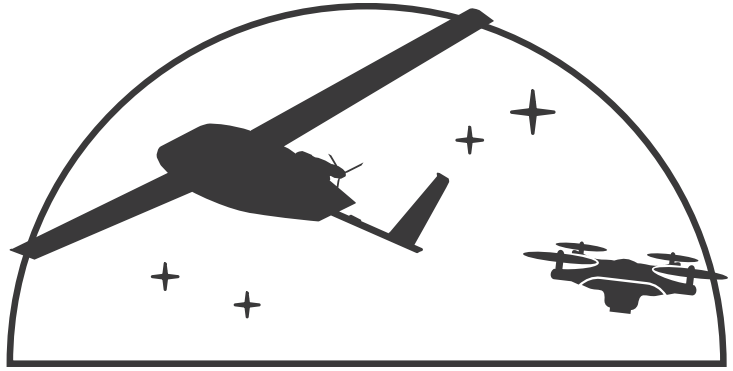
Current Training Gaps in m:N Operations

No standardized training exists for m:N operations, leaving operators potentially unprepared for managing multiple UAS.

- Operators often lack training in automation management and trust
- Current training oftentimes fails to address cognitive load and fatigue among operators supervising multiple UAS
- Enhanced training is needed to sustain SA in complex environments
- Effective training programs must integrate CRM strategies to improve communication and decision-making among operators

Rapid changes in m:N operations have resulted in unclear role definitions, leading to mismatched skill sets and inefficient task allocation.

Guidelines are needed for effectively enabling automation when operator workload becomes excessive.



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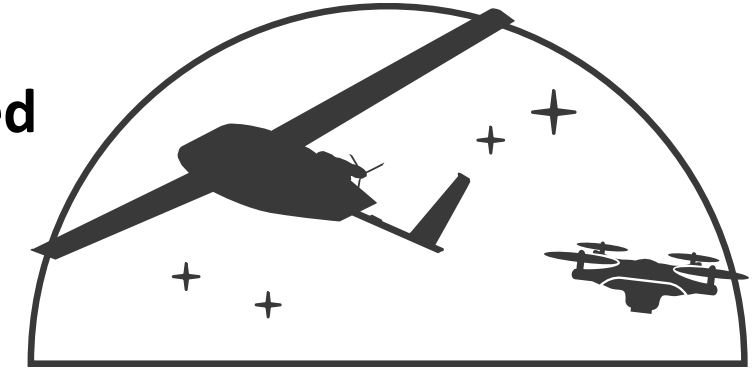
Evolving FAA Rulemaking for UAS Training

Flexible training programs are essential for equipping UAS operators with the skills needed to adapt to evolving operational demands.

- The FAA should **encourage the use of multimedia tools** (e.g., simulations, VR, etc.) to enhance learning outcomes, providing realistic experiences that improve knowledge retention and skill development

- **Integrating cybersecurity training** addresses potential vulnerabilities, ensuring operators can effectively protect UAS systems and manage data integrity

- Training should **prepare operators for overseeing automated systems** while maintaining safety through effective manual intervention



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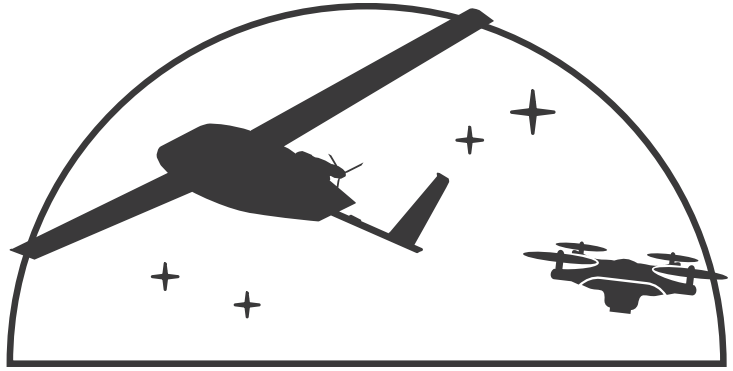
Next Steps

Moving forward, consider:

- Developing **comprehensive training modules** that include both simulator and real-world training
- **Performing task analyses** to determine optimal operator-to-UAS ratios based on cognitive load
- Incorporating lessons learned from DoD and public safety sectors to **refine operator selection and training processes**



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Proposed Guidelines

Safety Culture

Ensure **top-level training and operational safety** for all personnel involved, fostering a culture of safety across all roles.

Establish **clear operator designation and selection processes**, focusing on both technical skills and personal attributes that align with the organization's mission.

Training Development

Develop **comprehensive training programs** that include core Human Factors (HF) principles and specialized modules for managing workload and SA.

Implement **ongoing assessments using simulations** to evaluate performance and identify areas for improvement.

Operational Procedures

Analyze operator capabilities to **determine the maximum number of UAS manageable** by one or several operators, adjusting for automation, operational demands, and management by exception.

Establish mechanisms for collecting and integrating feedback from operators to **iteratively refine operational procedures** based on HF analyses.

Proposed Guidelines, Continued

Organizational Structures

Implement dynamic frameworks to **support real-time adjustments in personnel and task allocation**.

Ensure role clarity, efficient scheduling, and task rotation to **prevent fatigue and cognitive overload.**

Ensure that organizational structures and training programs are designed to **comply with applicable regulations, such as FAA Part 107 and Part 135.**

Personnel Selection

Establish dynamic frameworks that enable **real-time adjustments in personnel assignments and operational plans.**

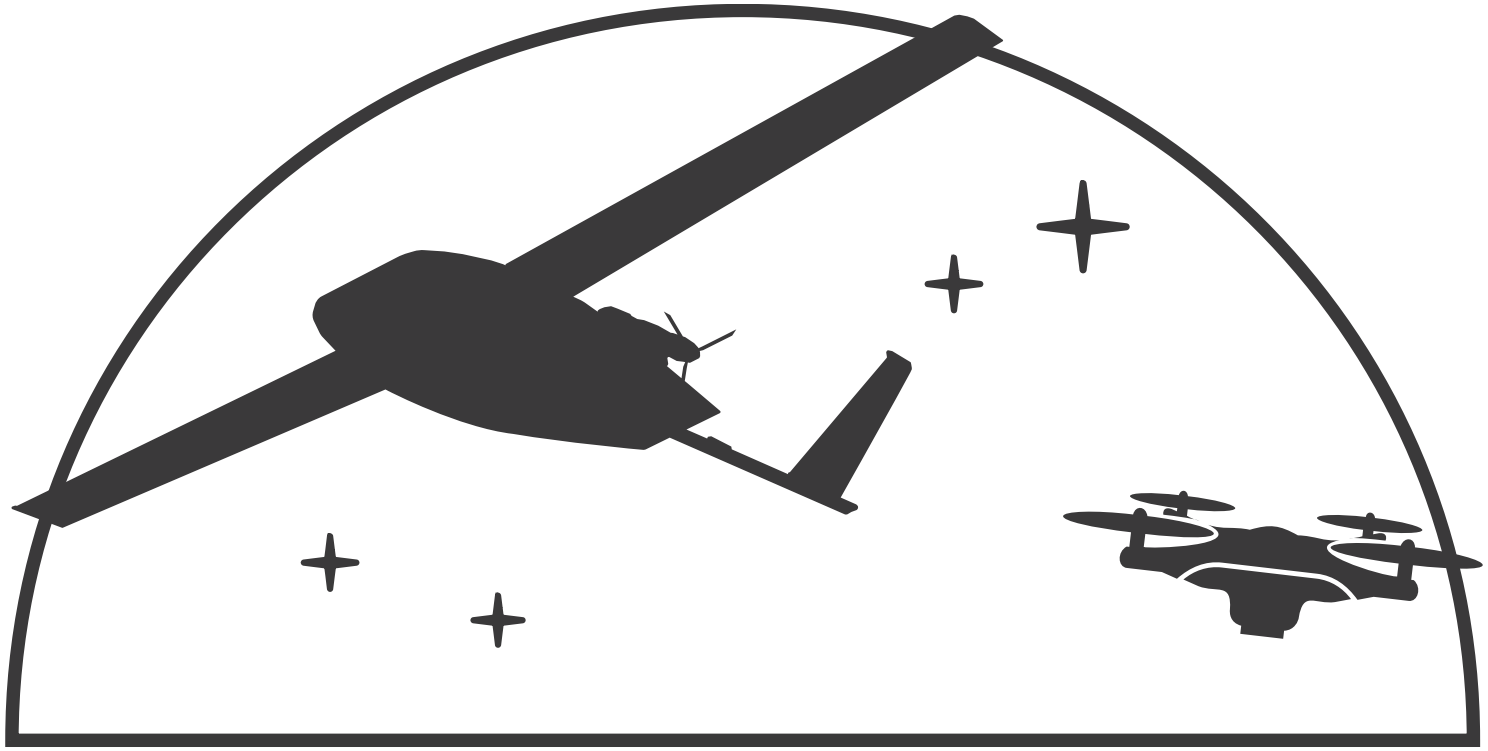
Ensure roles and responsibilities are clearly defined, and incorporate effective scheduling strategies with task rotation and regular breaks to **prevent operator fatigue and cognitive overload.**

Training

Develop **tailored Crew Resource Management training to improve teamwork, situational awareness, and communication.**

Utilize **simulation-based training** to manage real-life scenarios, emphasizing fatigue management, automation control, and cybersecurity.

Regular refresher courses and proficiency assessments ensure operators **stay current with evolving technologies.**



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