Engagement in Research and Training for First Responders

INCLUDING THE ASSURED SAFE PROGRAM

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A Bit of Context…

- Henry Cathey – Aerospace Division Director at NMSU's PSL
- Worked for NMSU for 29 years (I am Staff not Faculty)
- Mechanical Engineer by training – most of my career worked in R&D
- Decades working with High Altitude Stratospheric Balloons for NASA (6,000 to 8,000 lb payloads, 60,000 ft to 160,000 ft)
  - Balloon design, development, fabrication, testing, and flight missions
- Director of one of the 7 FAA Approved UAS Test Sites
- Focus on research for the FAA and other entities
  - Safe integration of new flight vehicles and technology
  - New aircraft and new sensor systems
  - (Detailed list of interesting research later in the presentation)
- Today I will split my time between some of the research and the education efforts specifically focused on Disaster Prep and Response

The Territory for Today

- UAS Vision for Disaster Preparation and Response
- Focus and Goals
- ASSUREd Safe
  - FEMA sponsored training for UAS operations and processing
  - Expanding set of programs to come
- Related Research
  - FAA focused research
  - Natural disasters and human caused disasters
  - Upcoming testing

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Information ….

- What do we need to make decisions?
  - Information
  - Actionable Information
  - "Timely, bite-sized, protein packed actionable information"
- Mindset Considerations
  - Engineer – I want all the data to analyze. I want to extract all the details (R&D)
  - Technology is great.
  - In this case, likely too much information.
- What is actually needed?
  - For R&D Engineering is one thing
  - For "snap decisions" is something else
  - How to deliver?....Timely, bite-sized, protein packed actionable information

"I wrote you a long letter because …

        I did not have time to write you a short one."

UAS In Disaster Response – Background

- Disaster response using UAS is *expanding*
- UAS can provide *safe alternatives* for many functions
- UAS can provide new and better data, support, and *actionable information* before, during, and after events
- While there are long established standards for response activities within FEMA, for many elements (ex. Incident Command Structure, communications, etc.), there have not been *uniformly accepted elements* pertaining to the use of UAS during disaster response
- *First Responder Training is essential for safe and positive operations during FEMA events*

UAS In Disaster Response - FEMA

The Department of Homeland Security (DHS) Fiscal Year 2023 Homeland Security National Training Program Continuing Training Grant.

- Awarded to Alliance for System Safety of Unmanned Aircraft Systems through Research Excellence (ASSURE) managed by the **ASSUREd Safe** Training Program.
  - The grant provides funding to ASSUREd Safe to ***develop and deliver FEMA-certified training solutions*** for local, state, and Tribal Nations to utilize UAS technology before, during, and after disasters.
  - All training is developed with FY22-26 FEMA Strategic Plan Goals at the forefront.

UAS In Disaster Response - FEMA

FY22-26 FEMA Strategic Plan Goals

- **Goal 1**: Instill Equity as Foundation
  - Prioritizes a diverse workforce, removes barriers to FEMA programs, achieve equitable outcomes

- **Goal 2**: Lead Community in Climate Resilience
  - Increase climate literacy, build climate resilient communities, empower risk-informed decision making

- **Goal 3**: Promote and sustain a ready FEMA and prepared nation
  - Strengthen emergency management workforce that can meet current and emergent threats, unify coordination and delivery of federal assistance

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UAS In Disaster Response

- UAS are "new to the party" so to speak

- Many technologies or applications evolve over time

- UAS (drones) are a new disruptive technology

- We need to apply these innovations into a mature existing system/infrastructure
  (think of adding something totally new and different to the existing Incident Command Structure)

UAS In Disaster Response - Program Need

- **ASSUREd Safe** training solutions to address national preparedness gaps
- Part 107 provides UAS pilots, training provides UAS pilots skilled in disaster response.
- The development of national UAS programs for integration in emergency management operations before, during, and after disasters.
- UAS system payloads will support the following missions:
  - Damage assessments,
  - Debris field measurements
  - Visual evidence for disaster declarations, insurance claims,
  - Flood levels, washouts, and erosion
  - Damages to homes, bridges, roads
  - Search and rescue operations
  - Logistics, disaster area communication, strategic response deployment
  - Package delivery in hazardous and hard to reach areas.

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Participating Schools

- Mississippi State University (MSU, ASSURE/**ASSURE**d Safe lead school)
- University of Vermont (UVM)
- Kansas State University (KSU)
- University of North Dakota (UND)
- Sinclair College (Sinclair)
- New Mexico State University (NMSU)
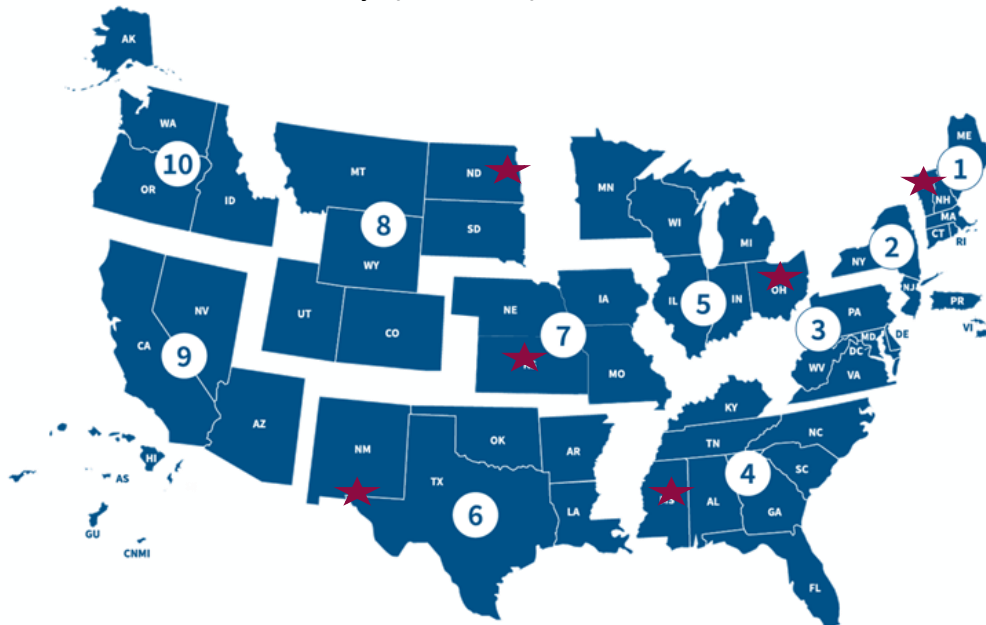
FEMA Regions and Target Schools

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Curriculum Delivery Schedule

- Initial **ASSUREd Safe** Schedule - 3 Courses per year
  - 3 Completed (September, October, and November 2023)

- Additional funding to expand **ASSUREd Safe** course schedule
  - 6 course offerings per year through 2026
  - 2024 NM, and Tribal Nations
  - 2025 and 2026 TX, OK, AR, LA, and Tribal Nations

The Challenge:
Current demand for training outstrips the ability to provide quality training

Curriculum – Development and Plan

- **ASSUREd Safe** Training
  - One year in development
  - **ASSUREd Safe** managing school selection for course delivery, purchasing UAS for flight operations, managing vendors, participant registrations, and management of FEMA and NIST relationships
  - K-State developed Day 1 Flight Operations Curriculum
  - UVM developed Day 2 UAS Data Processing and Analysis
  - All supporting schools have held classes since April 2023
  - 2 day in-person on-site class

Curriculum – Development and Plan

- Day 1 – UAS Flight Operations
  - 1-day, in-person, instructor-led course.
  - Organizational Considerations
  - Rules, Regulations, and Risk
  - Mission Planning
  - Flight Operations (including flight time)
- Day 2 – UAS Data Processing & Analysis
  - 1-day, in-person, instructor-led course
  - Organize, generate, analyze, and disseminate geospatial data from UAS imagery.
  - Generate data products to support damage assessment
  - Development of a shareable web app
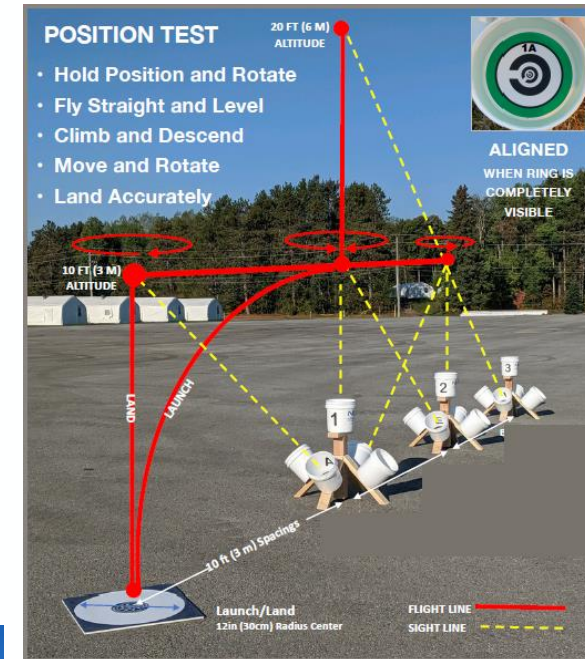
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Curriculum – Assessment and Feedback

- Educational Assessment – New World Kirkpatrick Model
  - Evaluations before, during, and after training to provide feedback for improvements
  - Training evaluation
    - Level 1: Reaction – Is the training favorable, engaging and relevant
    - Level 2: Learning – Degree of acquisition of intended knowledge
    - Level 3: Behavior – Application of training

  - Lessons learned gathered locally and combined nationally to improve the materials and training

Curriculum - UAS Flight Operations

- Flight Operations and Hands On Flying Exercise
  - Safety Briefing
  - Overview of Flight Exercises
  - Basic Flight Controls
  - UAS Pre-Flight Checklist
  - National Institute of Standards and Technology (NIST)
    - UAS Standard Test (using NIST "test lanes"
      - Basic skills
      - Evaluates "positive aircraft control"
      - Provides UAS familiarization to non-pilots

Day 1

POSITION TEST
- Hold Position and Rotate
- Fly Straight and Level
- Climb and Descend
- Move and Rotate
- Land Accurately

20 FT (6 M) ALTITUDE

10 FT (3 M) ALTITUDE

ALIGNED WHEN RING IS COMPLETELY VISIBLE

Launch/Land 12in (30cm) Radius Center

FLIGHT LINE
SIGHT LINE

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Curriculum – Data Processing and Analysis

- Organize and edit a set of UAS imagery displaying damage to a neighborhood

- UAS Imagery processing to create geospatial products

- Perform damage assessments by analyzing the geospatial products

- Geospatial integration and analysis of UAS video

- Development of a sharable web application to support disaster response

Day 2
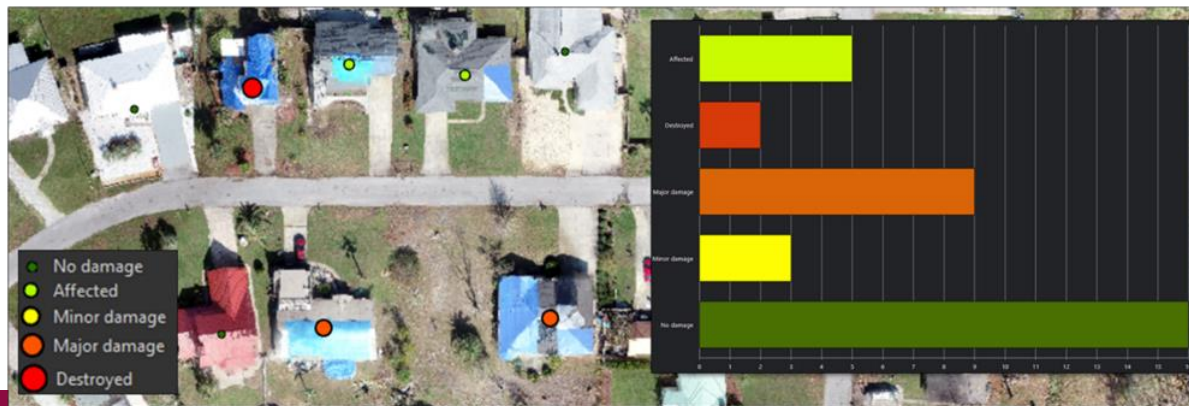
Course Delivery Update and Lessons Learned

- NMSU 2023 Trainings (can have 12 to 15 people per offering)
  - September 27 and 28, 2023
  - October 11 and 12, 2023
  - November 14 and 15, 2023
  - Lessons Learned Types
    - Participants – Each comes with a different background and level of experience
    - Expectations – Geographic Information System (GIS) is difficult for first time users (think of day 1 being action, and day 2 brain work and math)
    - Logistics – NMSU parking pass system
    - Feedback – Capture all feedback given
  - Participant Feedback
    - Day 1 Flight Operations course was high level, comprehensive and triggered many questions for the instructors and to bring back to their own teams
    - Day 2 Data Analytics was interesting and challenging and provided a level of clarity around requirements for integrating UAS technology in disaster response

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NMSU Future Schedule

- Originally planned for 3 training courses per year
- Program expanded after inception (demand is great!)
- 6 training courses delivered in each year 2024, 2025 and 2026

- 2024
  - New Mexico: Gallup, Taos
  - Tribal Nations: Pueblo, Navajo, Zulu, Apache
- 2025
  - Texas: Amarillo, Fort Stockton, Dallas
  - Oklahoma: Oklahoma City
  - Tribal Nations: Choctaw, Cherokee
- 2026
  - Arkansas: Little Rock
  - Texas: Dallas, Houston, San Antonio
  - Louisiana: Shreveport, Baton Rouge

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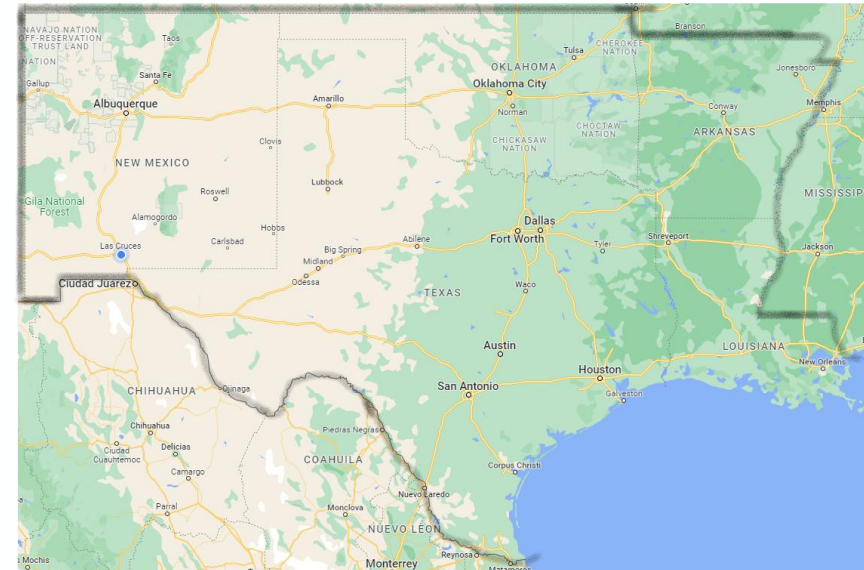
FAA ASSURE Research

- FAA funded research under the Alliance for System Safety of UAS through Research Excellence) ASSURE
- NMSU has worked on many different efforts
  - Counter UAS
  - Detect and Avoid (DAA) to enable Beyond Visual Line of Sight (BVLOS)
  - Human Factors focused on Visual Observers
  - UAS and Cyber vulnerabilities
  - UAS operations near airports
  - Shielded UAS operations
  - Disaster Prep. and Response
  - Minority STEM Outreach – UAS as the central learning platform for K-12 UAS Roadshows and summer camps
- FAA designated funding for Disaster Preparation and Response
- Four phases of development (7 Universities)
  - Phase I completed
    - A28 – Disaster Preparedness and Response – Phase I (A28_A11L.UAS.68)
    - https://assureuas.org/projects/disaster-preparedness-and-response/
  - Phases II and III are in process now
  - Phase IV coming soon

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Disaster Response Research

- This research provided insight into the safe integration of UAS into the disaster preparedness and response areas.
- This research looked at how UAS can aid in disaster preparedness and response to different natural and human-made disasters.
- It focused on procedures to coordinate with the Department of Interior (DOI), the Department of Homeland Security (DHS) including the Federal Emergency Management Agency (FEMA) and other federal, local and state governments to ensure proper coordination during those emergencies.
- These research results will develop requirements, technical standards, policies, procedures, guidelines and regulations needed to enable emergency response operations for UAS.
- Effective and efficient use of UAS in a disaster were the two primary goals of this project.
- This offers an effective tool to assist first responders to save lives faster and accelerate personnel and infrastructure recovery.

Disaster Response Research

- A28 Final Report   https://assureuas.org/projects/disaster-preparedness-and-response/
- Final Report Appendices:
  - Appendix A: Questionnaires, Surveys, and Results
  - Appendix B: Case Studies – Historical Disaster Characterization Report
  - Appendix C: MSBE Communications and Interactions of Disaster Case Studies
  - Appendix D: UAS Use Cases and Usage Challenges
  - Appendix E: Operational Risk Assessment
  - Appendix F: Risks, Waivers, and Mitigation Report
- Final Report Attachments:
  - Attachment 1: CONOPs for Airport Terrorism
  - Attachment 2: CONOPs for Earthquake and Tsunami
  - Attachment 3: CONOPs for Hurricane, Tornado, and Flooding
  - Attachment 4: CONOPs for Oil Spill
  - Attachment 5: CONOPs for Pandemic Use of Large UAS
  - Attachment 6: CONOPs for Pandemic Use of Small UAS
  - Attachment 7: CONOPs for Train Derailment
  - Attachment 8: CONOPs for Volcano
  - Attachment 9: CONOPs for Wildland Fire #1
  - Attachment 10: CONOPs for Wildland Fire #2
- Part 107 Document: Beyond Part 107 Document

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Disaster Response Research

- NMSU is currently planning on UAS operations to support a prescribed burn. Since this is ongoing research, only an overview is provided.

- Multiple test flights and operations planned over a 2 month period to integrate systems, prepare and fly operational scenarios, and data processing

- Multiple different UAS to support

- Multiple different sensors to be flown

- Culmination in flight ops over a prescribed burn being conducted by the Forest Service (likely in Arizona)

Disaster Response Research

- General overview of operation
  - Fixed wing aircraft for situational awareness overflight
  - Multicopter on a tether for situational awareness overflight
  - VTOL/fixed wing for situational awareness overflight
  - Multicopter for real time tasking
  - Fixed wing for real time tasking
  - Optical cameras
  - Multispec camera
  - LiDAR
  - Pre and post event flights to map the area (fuel load assessment)
- Again, this is an effort in process with flights before May of this year. More details to follow…

Final Thoughts….

- With UAS it is all about Safety!
- New technologies require new paradigms
- Must be integrated into existing structures safely
- Common skills and language for UAS operators are required
- Current research is focused on providing structure, guidance, and inputs for common sense rules and regulations
- Safety!

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