Advancements in Remote Ground Control Station Operator Pilot in Command Training Program for Beyond Visual Line of Sight Flight Operations

Jacob Revesz[1], James Unverrict[2] , Bryan Petty[3], Bill Buck[3], Louis Glaab[3]

ViGYAN, Inc[1]
Analytical Services & Materials[2]
NASA Langley Research Center[3]

Aviation, July 29 – August 2, 2024

Introduction

- sUAS remote pilot training program was developed by NASA to bridge the gap between visual piloting and remote piloting.
- Previously operations were conducted via visual line of sight (VLOS)
- Modernized infostructure and training were developed to fulfill the requirements of beyond visual line of site (BVLOS) operations.
- Training procedures were developed using a human factors technique called Hierarchical Task Analysis (HTA)
- Certification as a NASA Remote Pilot consisted of a combination of simulation training and live flight training

Capabilities Supporting Training

SIVL Training Lab Source: NASA

ROAM UAS Operations Center Source: NASA

Capabilities Supporting Training

MOSAIC Remote Flight Operations Center Source: NASA

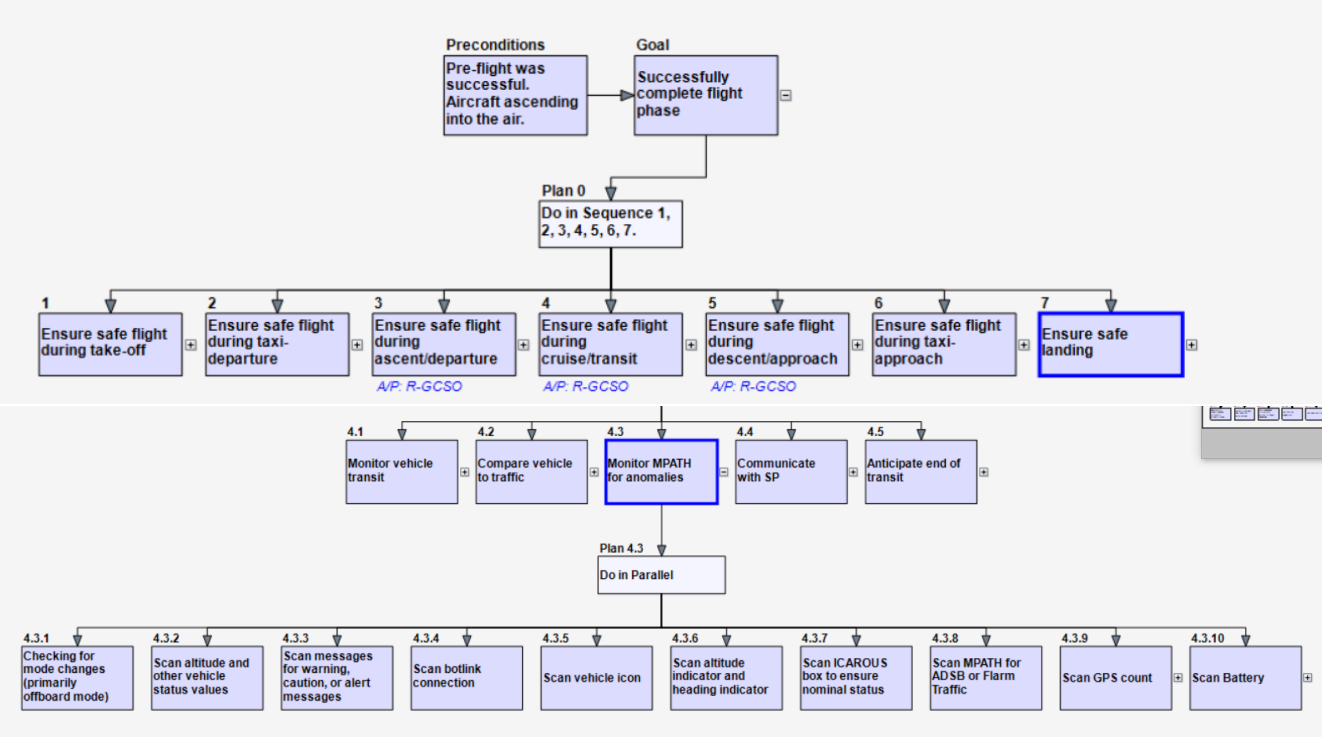
NASA CERTAIN Flight Test RANGE Source: NASA

Training Development

- We investigated the roles responsibilities and training requirements of remote ground control station operator pilot in command (R-GCSO PIC) crew position.
- Hierarchical Task Analysis was conducted to investigate the responsibilities of the R-GCSO PIC crew position.
- A BVLOS safety case was submitted and approved to the FAA outlining the areas required to be trained.
- Nine emergency/contingency scenarios were developed and testing in the simulator prior to training the R-GCSO PIC Trainees.

Training Development (HTA)

- Performed cognitive interviews with expert pilots after live & simulation flights
- Provided insights into potential errors that may occur



Training Development (Responsibilities)

- Vehicle pre-flight check
- Flight path planning
- Contingency parameter programming
- Preflight planning/coordination
- Takeoff
- Flight path monitoring
- Issuance of vehicle commands
- Vehicle status situational awareness
- Airspace situational awareness
- Traffic conflict response
- Landing
- Post-flight coordination
- Emergency procedures
- Crew coordination

Source: NASA

PIC Assessment Criteria

- **Decision-Making Skills**
  - Actions and communications must be clear, confident, concise, correct, and timely.
  - Responsiveness to off-nominal events and execution of corrective procedures evaluated.
- **Pilot Confidence**
  - Ability to execute Instructor pilot (IP) commands promptly and accurately.
  - Ensured trainees could perform tasks decisively.
- **Callouts and Communication Evaluation**
  - Proper callouts during all flight phases.
  - Communication protocols critical for safe operations.

PIC Assessment Criteria

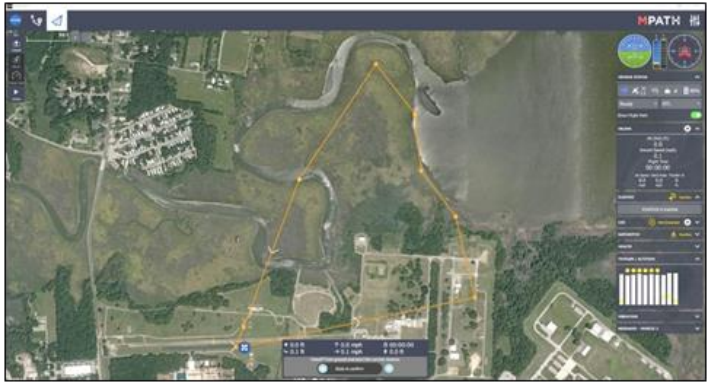
- **Verification of Scenario Success**
  - Scenarios scripted but re-evaluated if necessary.
  - Ensured trainees met criteria for scenario success.
  - Debriefing with IP used to correct mishandled scenarios.
- **Conformance to Procedure Assessment**
  - Knowledge of air traffic control protocols, airspeed, and altitude limitations evaluated.
  - Performance must adhere to NASA's procedures.
  - Oral evaluations during training scenarios and live flights.

Simulation Training

- Introduced trainees to the system command and control architecture and ground control station applications
- Covered failsafe and contingency programming.
- Conducted 5 nominal sorties around the NASA CERTAIN Flight Test Range covering standard operating procedures and radio callouts.
- Conducted 9 sorties with inflight emergency scenarios
  - GPS Failure, Motor Failure, Traffic Avoidance, Battery Failure, and Link Loss
    - Full list and descriptions are explained in the paper.

Live Flight Training

- Flight operations were conducted from the remote operations center
- Four live sorties were flown per trainee
- Remotely preflight the aircraft with ground crew in the field
- Autonomous system activates and navigates against live intruder aircraft
- Manual point-to-point navigation to vertiport for landing
- Active monitoring of integrated airspace display



MPATH Ground Control Station

Source: NASA

Training Design Recommendations

- Expand simulation training catalog to include a wider range of scenarios.
- More instructor friendly simulator interface that doesn't require a simulation engineer to operate.
- Bring more subsystems online in the simulator to make the flights more realistic.
- Conduct training events in blocks of four hours to prevent cognitive decline.
- Provide more formalized training for instructor pilots on diverse teaching and communication styles to foster a better learning environment.

AMERICAN INSTITUTE OF
AERONAUTICS AND ASTRONAUTICS