



#ASPIRE24

Qualitative Data Coding of User Experience With an Urban Air Mobility Fleet Manager Interface

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Introduction

Background

- Market boom projected in **Unmanned Aerial Systems (UAS)** and **electric Vertical Takeoff and Landing (eVTOL)** aircraft
 - Passenger transportation (e.g., NUAIR, 2021)
 - Cargo transportation (e.g., Wolter et al., 2023)
 - Wildfire response (e.g., Martin et al., 2021)
- **Human and Autonomy Team (HAT):** A HAT could be responsible for an organization's entire fleet of UAS (not just a single vehicle)
- **Fleet Manager (FM):** As the use of autonomous systems increases, there will be a need to manage multiple aircraft simultaneously



Image Credit: NASA/Joby Aviation





High Density Vertiplex

Project Description

- The **High Density Vertiplex (HDV)** was created to address issues associated with air taxis flying in urban environments
 - **Vertiplex:** A network of takeoff and landing areas, similar in nature to heliports
- Conduct live and simulated flight tests to study terminal area eVTOL operations in a prototype **Urban Air Mobility (UAM)** ecosystem
- HDV implemented a highly automated airspace management system and automated tools; **Fleet Manager Interface (FMI)**

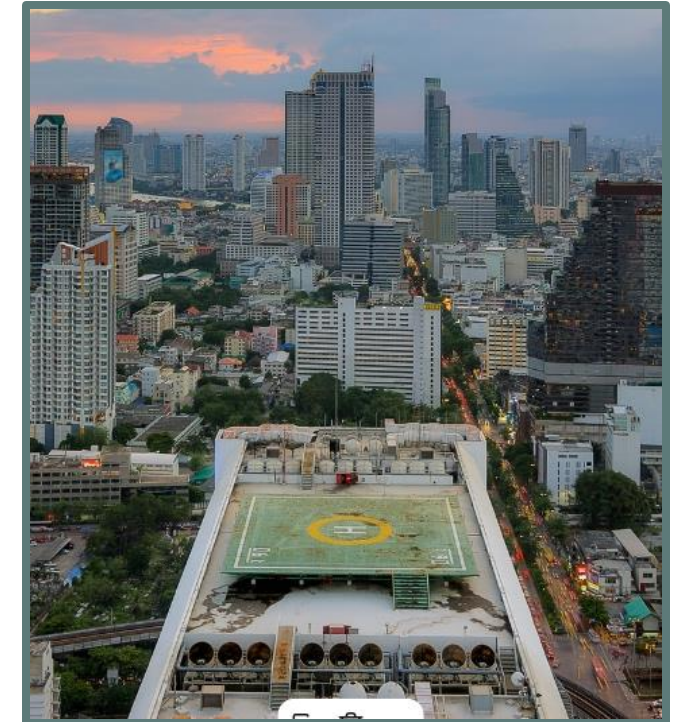


Image Credit: Canva





Fleet Manager Interface

Components

- **Map:** Displays airspace
- **Schedule Page:** For scheduling flights
- **Operations Page:** Provides status updates about flights
- **Missed Approach:** Tool that partially automates a nominal flight procedure
- **Notifications:** Alert indicating that an action is required

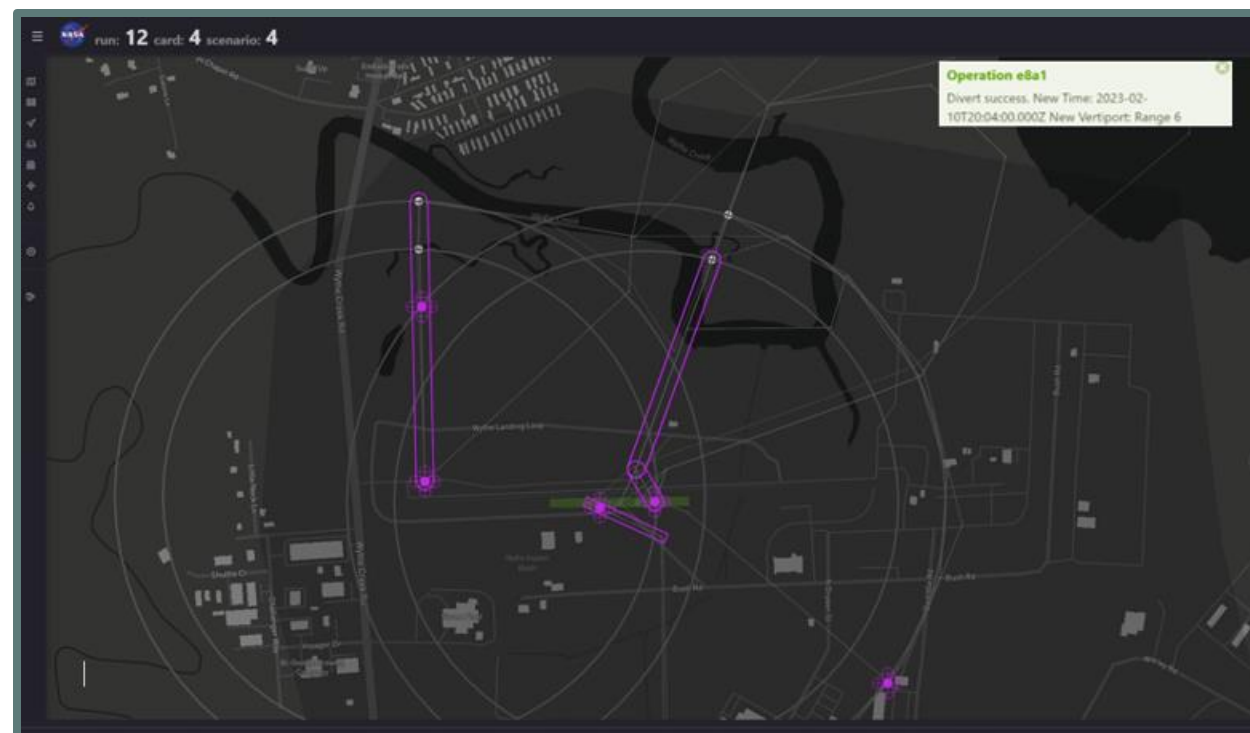


Image Credit: NASA/Hodell et al. (2024)





Fleet Manager Interface

Human Factors Assessment of FMI

- Multiyear project, UX research identified info requirements to improve situational awareness and decision support for FMs
- Previous work on HDV produced results that were useful for obtaining a *global* sense of the FMI's acceptability
- The present UX assessment seeks to highlight specific aspects of the UI that could be improved via open-ended questionnaires



Image Credit: Canva





Participants and Apparatus

Participants

- **Six participants** recruited from NASA Ames Research Center acted as Fleet Manager
- Backgrounds included engineering, flight ops, user research, and software development

Apparatus

- The FMI was used as the primary workstation for participants in the FM role
- Designed to integrate with external systems and make operational context available



Image Credit: NASA/Hodell et al. (2024)





Procedures

Study Runs

- Five study runs, each lasted 30 mins, consisted of a 20-min flight scenario and 10 min of questionnaires
- Participants used the FMI to control multiple aircraft in a live/virtual flying environment
- **Flight Scenarios:**
 - Nominal
 - Missed Approach
 - Speed Change
 - Divert
 - Multi-Aircraft Divert

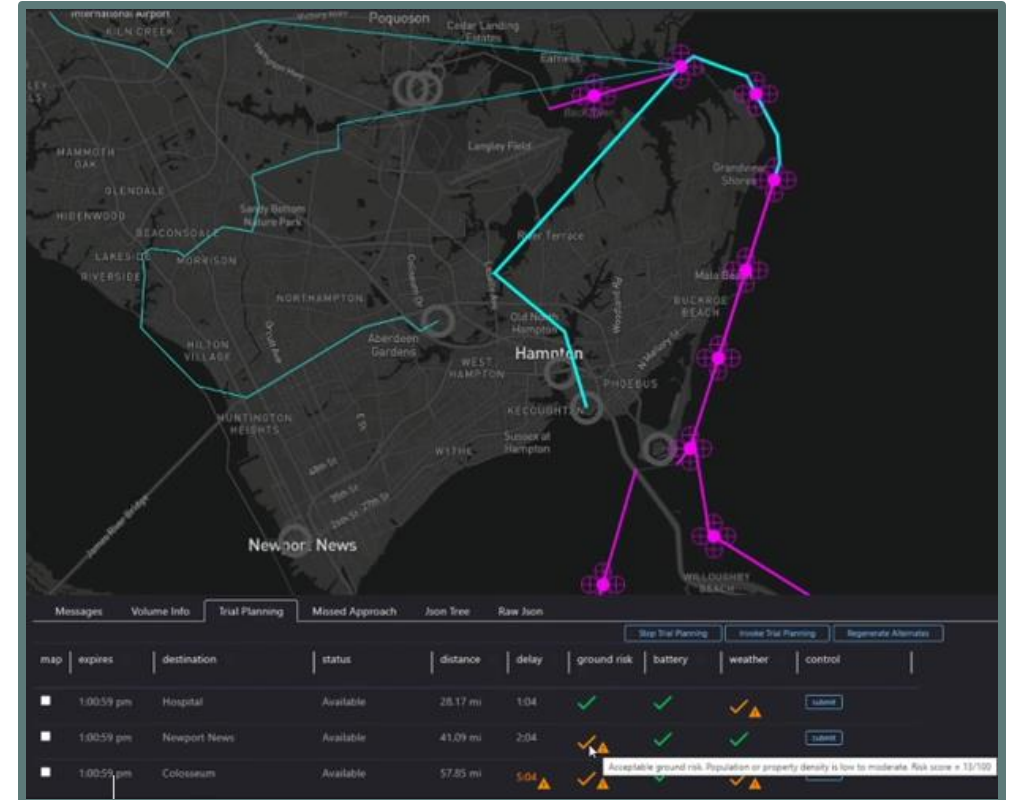


Image Credit: NASA/Hodell et al. (2024)





Measures

Questionnaires

- **Between-Runs Questionnaires:** Customized to the scenario that was run last, assessed the FMI on numerous topics
- **Post-Run Questionnaire:** Adapted from the Post-Study System Usability Questionnaire (PSSUQ; Lewis, 1992)
- Open-ended response boxes for comments and feedback
- Response topics included
 - Usability and user experience
 - Understandability and confusion
 - Confidence in decision making
 - Features that should be modified/removed

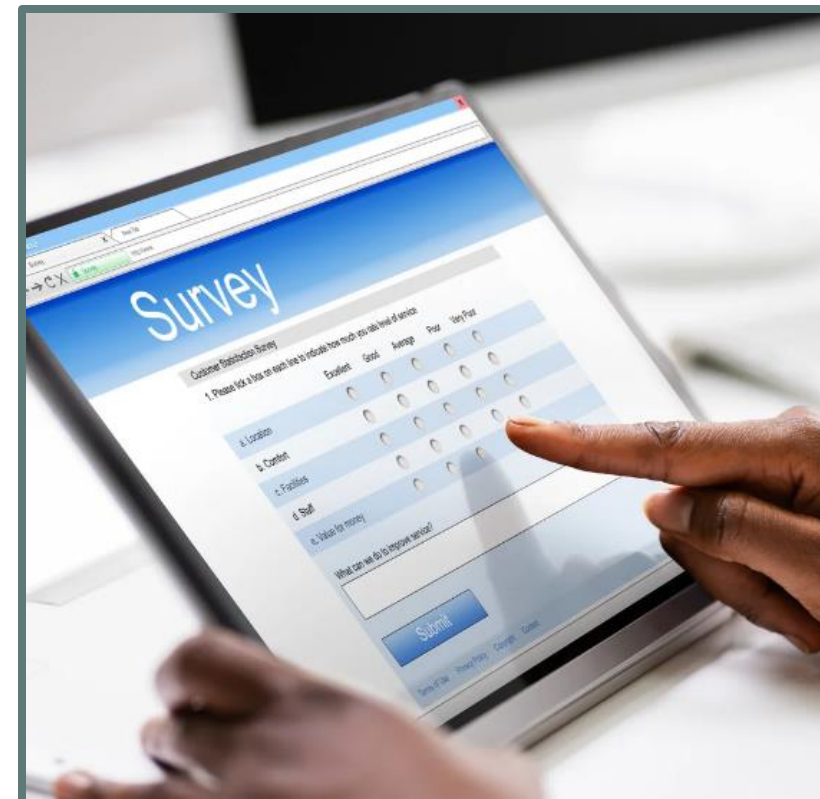


Image Credit: Canva





Qualitative Data Coding

Overview

- **Qualitative Data Coding:** Process of methodically labelling language-based data, readily highlights patterns/trends
- **Inductive Coding:** Codes developed based on the language in the dataset (Linneberg & Korsgaard, 2019)
- **Deductive Coding:** Uses pre-defined codes that are developed prior to scoring the dataset (Linneberg & Korsgaard, 2019)



Image Credit: Canva





Directive String Coding

Qualitative Data Coding for HDV

- **Directive String Coding (DSC):** Developed for analyzing the open-ended HDV responses
- DSC implemented a **blended approach**, using both inductive and deductive coding
- A “string” of parent codes and subcodes were assigned to each question and response

Action: **Add** > Point of Interest: **Map** > Keyword: **Information**
 > Description: **Vehicle’s callsign**

Parent code	Subcodes
Action	Add (to UI) Modify (UI) Remove (from UI) System/concept of operations User experience
Point of interest	Missed approach Operations page General FMI Map Notifications/messages
Keyword	User experience Data visualization Functionality Automation/AI Click count Decision making Display/layout Feedback (from UI) Functionality Information Process/steps
Description	Brief clarification/specifying explanation

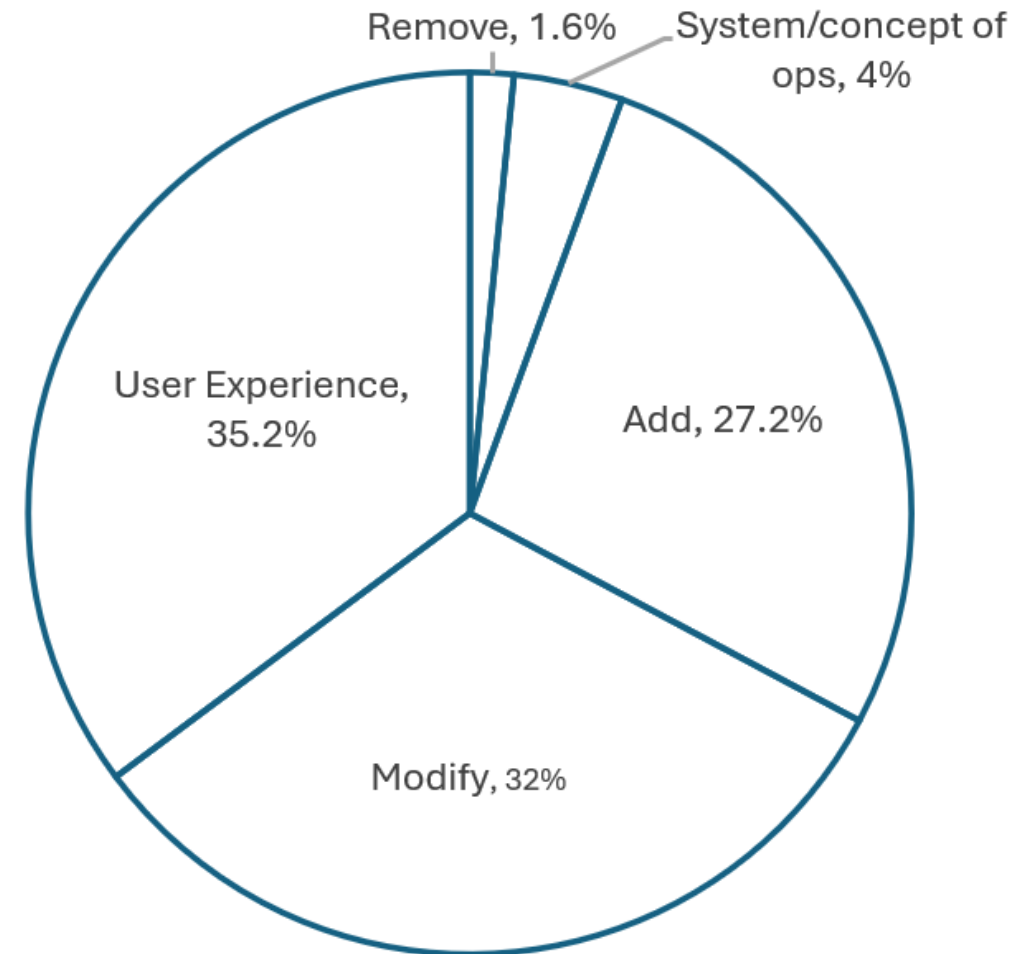




Action Parent Code

Distribution of Responses

- Largest proportion of responses were coded as User Experience
- Smallest proportion of responses were coded as Remove
- Suggests that very little should be removed from the FMI
- The existing components of the UI should be modified or added to

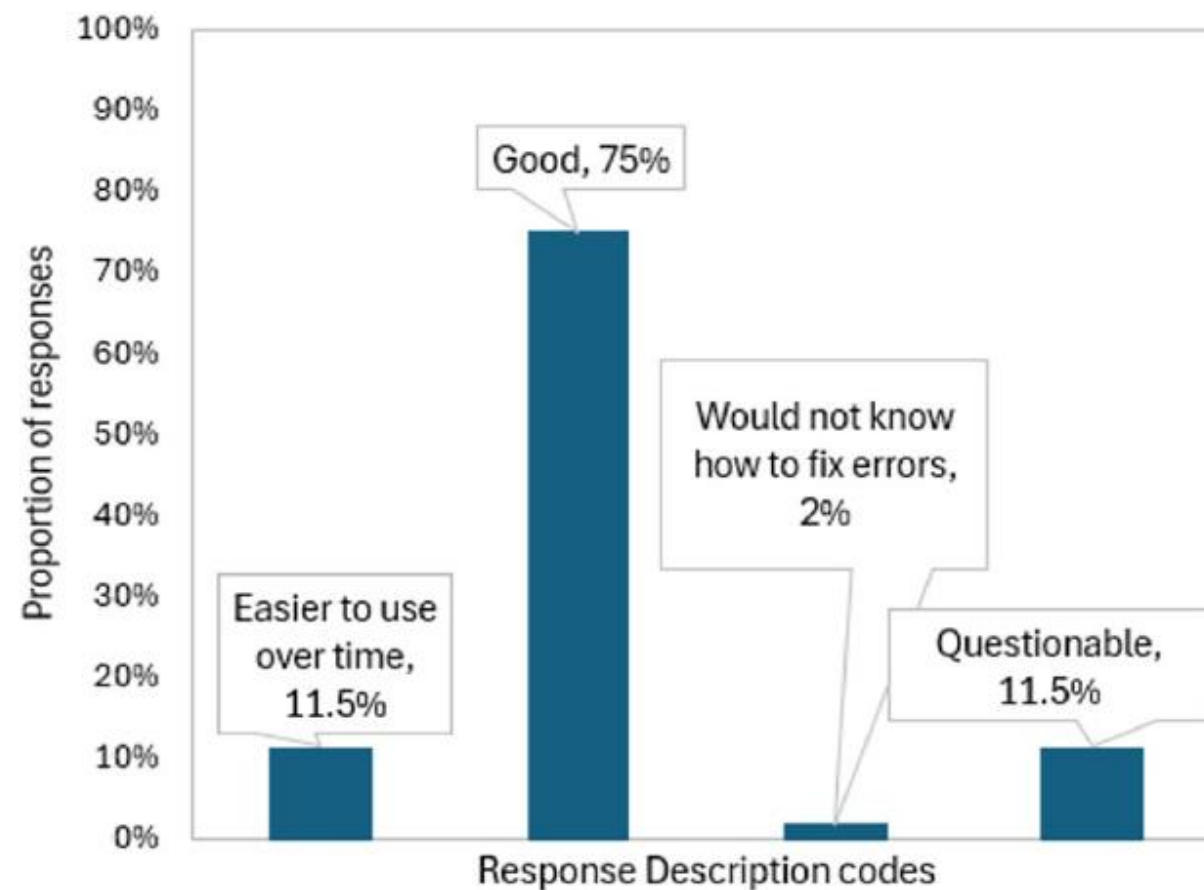




User Experience

Results

- 86.5% User Experience feedback was positive
 - “Good” (75%)
 - Easier to use over time (11.5%)
- Corroborated by the interpretation of the numerical PSSUQ scores
- FMI usability score was better than the normalized overall PSSUQ rating



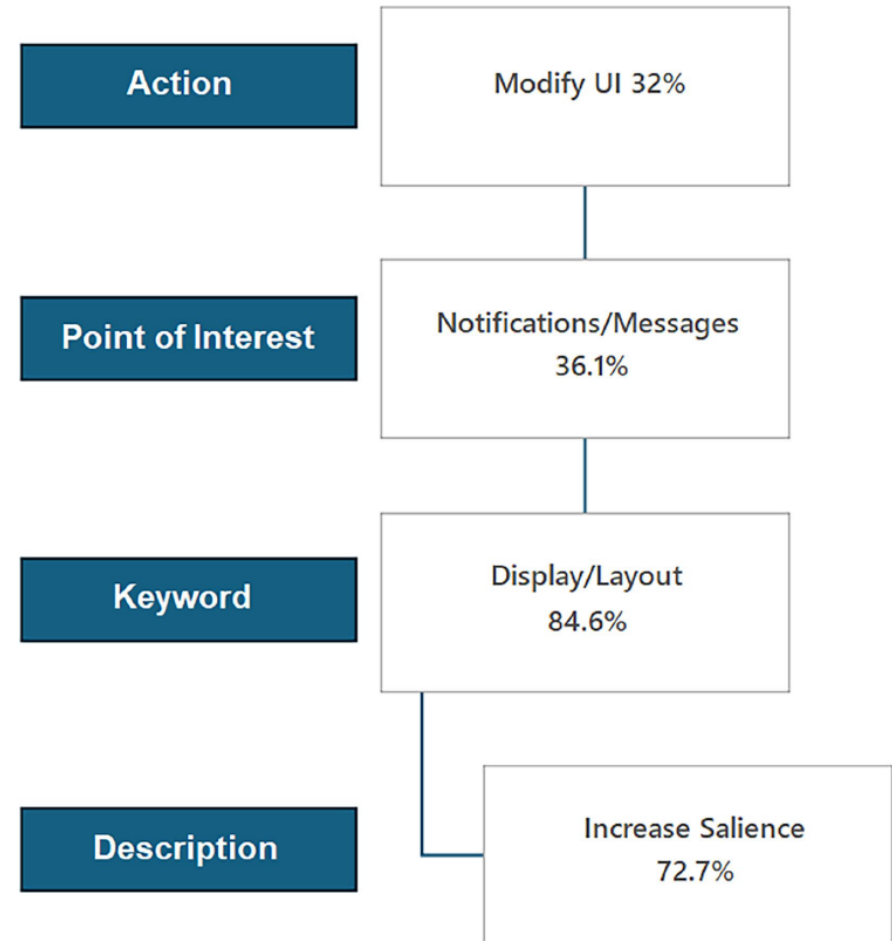


Modify

Results

- Second largest proportion of responses were coded as Modify
- The top Point of Interest code was Notifications / Messages
- The primary Keyword was Display/Layout
- For Description, the largest proportion of responses involved increasing salience

Action: **Modify** > Point of Interest: **Notifications** >
 Keyword: **Display** > Description: **Increase Salience**





Discussion: Fleet Manager Interface

Main Findings

- User experience was overwhelmingly positive, this suggests that the FMI may be a suitable asset for continued research
- Notifications/messages should be more salient, with pts reporting that they look like irrelevant pop-ups or could be missed entirely
 - As human operators begin to manage multiple aircraft, there will be heavy reliance on automated notifications (FAA, 2023)
- Information across multiple screens and displays should be consolidated
 - Map was the most monitored screen, pts wanted more info on the map to reduce need to switch between screens

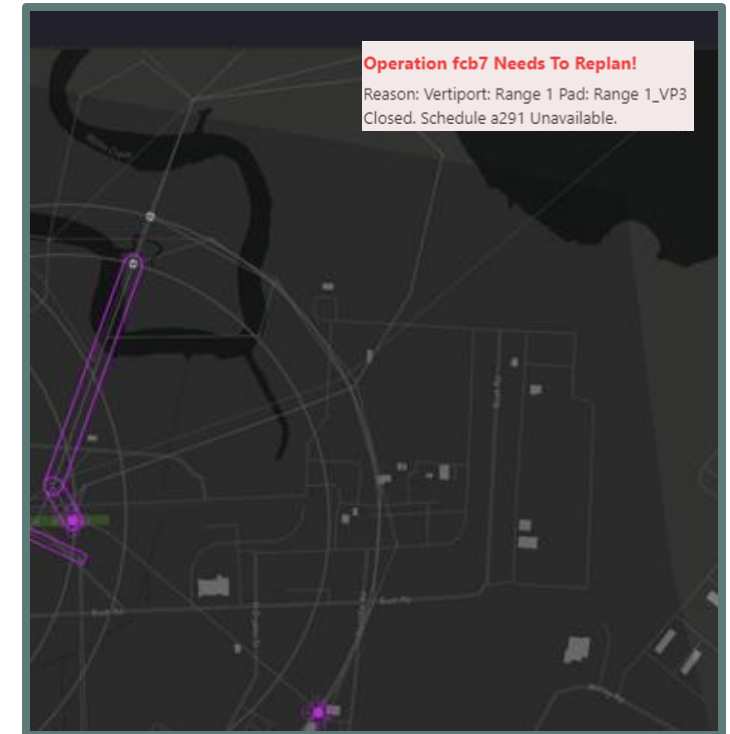


Image Credit: NASA/Hodell et al. (2024)





Discussion: Directive String Coding

Main Takeaways

- DSC should be viewed as a strategy for organizing qualitative data in a way that creates actionable feedback for future consideration
- DSC has not been formally compared to other qualitative data coding techniques or validated rating scales
- Consistent with previous qualitative data coding methodology (e.g., Blair, 2015), should be assumed that modifications to DSC will be needed to meet the needs of different studies/datasets

Comment	Action	Point of Interest	Keyword	Description
Would be higher if I could figure out how/why certain pop-ups open, but it felt like pure luck at times (had to like triple click the "x" to get the pop-up to close)	UI Modify	Map	Functionality	Opening and closing data-tags
Not sure what is meant by "different"... It's easily missed the first few times using the GUI due to the multiple horizontal rows of information, maybe if it were a different color or somehow more easily identifiable, that could be useful	UI Modify	Missed approach	Display/layout	Row banding
Perhaps, the "Generate missed approach" button could be located more to the left, since I tend to visually search for things from left to right	UI Modify	Missed approach	Display/layout	Move "generate" button to left
It is very easy and straightforward to access the Missed Approach tab from the Operation submenu. Different visualization styles/options can be taken into account to enhance the tab visualization but this represents a minor consideration.	UI Modify	Missed approach	Display/layout	Enhance tab visualization
Only change I would like to see is after a missed approach is engaged, I would like the submit button to be greyed out or turn green showing positive submission on top of a notification.	UI Modify	Missed approach	Feedback	Submit button should change





Conclusions

Summary

- Participants who assumed the role of FM were surveyed on their user experience with the FMI, open-ended responses were analyzed using the DSC qualitative data coding technique
- DSC allowed researchers to develop a rich and detailed understanding of the FMI UX by organizing comments into concise, actionable feedback
- Overall, the FMI appears to be a viable asset worth researching further, with some of the main findings suggesting that notifications/messages be made more salient and the information across multiple screens consolidated when possible

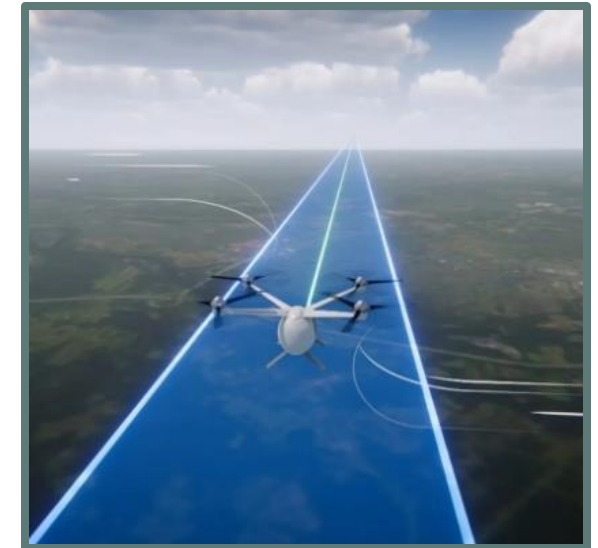


Image Credit: NASA/Kyle Jenkins





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