



**Proposed Flow Management Data and Services Design Prototype**

**San José State University  
Traffic Flow Management - Application Integration Design Challenge**

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# Table of Contents

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<b>Table of Contents</b>	<b>2</b>
<b>1 Quad Chart</b>	<b>3</b>
<b>2 Introduction</b>	<b>4</b>
2.1 Summary Statement	4
2.2 Project Description	4
<b>3 Background and Timeline</b>	<b>5</b>
3.1 Research	5
3.1.1 Literature	5
3.1.2 Interviews	5
3.2 Persona	6
3.3 Users	6
3.4 Use Case	7
3.5 Flow Chart	8
<b>4 Final Prototype</b>	<b>10</b>
4.1 Main Dashboard	10
4.2 FEA/FCA	11
4.3 AFP	13
<b>5 PDR to CDR</b>	<b>14</b>
5.1 Actions and Recommendations	14
5.2 Main Dashboard	15
5.3 AFP	16
5.4 FEA/FCA	16
5.5 Flow Chart	17
5.6 Other Updates	18
<b>6 Project Schedule</b>	<b>19</b>
<b>7 Prototype and Video</b>	<b>19</b>
7.1 Prototype	19
7.2 Video	19
<b>8 References</b>	<b>20</b>

# 1 Quad Chart



Federal Aviation  
Administration

San José State University

Proposed Flow Management Data and Services Design Prototype

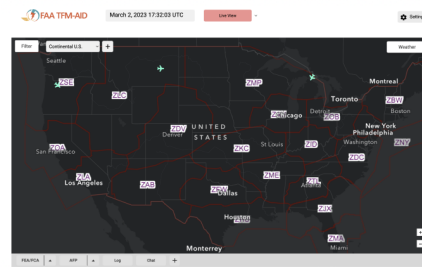


TFM-AID  
TRAFFIC FLOW MANAGEMENT -  
APPLICATION INTEGRATION DESIGN CHALLENGE

## Project Description / Requirements

- Creation of a clean and simple dashboard
- The new dashboard will allow users to access as many functions as possible within a few clicks
- Logging and implementation of advisories
- Modeled screens to create a interactive, visually appealing and less cluttered experience for the user

## Image/Graphic



Frame 1

## Risks / Issues

- Issue: Usage of new system (training gap)
- Issue: Visual clutter (Fitts Law)
- Risk: Disability coloration (color impairment)

## Next Steps

- Conduct usability test for prototype on ATMs
- Transition prototype to web based system
- Coordinate and learn from other competitors in the competition

## 2 Introduction

### 2.1 Summary Statement

The goal of our proposed Flow Data Management and Services (FMDS) redesign is to create a cohesive program that integrates all the necessary functions of traffic flow management into a single interface that is easy to navigate and intuitive to use.

At the center of this design is a modular dashboard that can be customized according to a user's individual needs and primary tasks. Our prototype prioritizes short workflows and consolidating information. This allows users to perceive fewer windows and steps to accomplish a task, easing cognitive congestion and improving visualization of all necessary information throughout a workflow.

We have placed a heavy emphasis on the idea of "recognition versus recall" throughout our design, keeping relevant information visible to a user throughout the process, so they do not need to click away from a target screen to obtain the information they need. Recognition versus recall emphasizes that the user should not have to rely on their working memory to retain information, rather the system should facilitate the users memory through functions of the interface.

### 2.2 Project Description

Our approach for the FMDS design stemmed from several key goals, which were drawn from the original design brief and the main points addressed in the Q&A (FAA, 2022). Chief complaints were the lack of continuity, both in the need for multiple applications, the "death by windows" caused by having an abundance of applications in use, and the lack of visual continuity between those applications. Additionally, we took note of the lack of effective visualization in the original program, with users having to manually enter in many of the parameters when creating FEA/FCAs, AFPs and other TMIs. We found this method to be functionally limited, and created additional workload for users, especially novice or less experienced users who would have less familiarity with the systems and their intended goal.

In addressing these concerns our goal was to create a centralized application that all the primary functions outlined in the brief could be operated from. By creating a centralized application, some of the primary pain points in the brief were easily addressed. The amount of windows displayed could be reduced, the need to continuously reenter information was largely eliminated through a combination of autofill functions, and the fact that more functions can be accomplished from a single page.

We decided to focus on creating a clean, simple dashboard that allowed users to access as many functions as possible with fewer clicks. Understanding that user preferences and needs may vary, we also decided to make our dashboard modular in design. This allows for different programs or functions the ability to move around or be removed entirely from a dashboard view if they were not relevant to the individual user. In our second iteration since the preliminary design review, we have focused on creating a single screen view, with the intention that some of the functions could easily be transferred to a second monitor if a user has one available and prefers to do so. While being able to spread information out across more screens can often be helpful, especially when navigating complex applications, we

recognize that this may not be possible in all settings, and wanted to ensure that a single screen user would be able to use the application with as much ease as a multi screen user.

## 3 Background and Timeline

### 3.1 Research

#### 3.1.1 Literature

To better understand the overall design and functionality of the original design we looked over the dashboard doc. We referenced the “Thin Client Traffic Situation Display” and “Traffic Flow Management Concept of Operations for Flow Management Data and Services (FMDS) for Investment Analysis Readiness Decision (IARD)” manuals to assist us during the design process. For our AFP we used another manual to assist us, it was the “Flight Schedule Monitor User’s Guide”. We were all given a reference guide to help us during the competition. Fitts Law, Hick’s Law, Gestalt Principles, and recognition rather than recall were all design principles that we applied (or could apply) during the design process.

#### 3.1.2 Interviews

To gain more insight in the process of air traffic control and management, our team reached out to specialists with air traffic control through LinkedIn. Through our outreach, we were able to interview and learn some of the challenges workers in the general air traffic field face. Our first point of contact was Tiffany Ling, an ATC Specialist at the FAA (OAK Tower). Although she was an air traffic controller, she was able to share with our team the perspective of working with an air traffic manager and how the internal components of air traffic are organized. Another point of contact we found was Wayne Bridges, retired Supervisor ATC Specialist for the FAA and currently working as a Senior Air Traffic Control Associate at NASA. With decades of experience in air traffic flow management, he was able to help our team conceptualize all components of the intricate system and provide examples by referring to local airports and towers. With these insights, our team was able to accurately depict the persona, flow chart, and empathize issues faced when navigating the air traffic management system.

## 3.2 Persona

As we developed our prototype, it was critical to consider who our primary users are and what their past experience and needs are. We developed the below persona to help define those needs.



### Air Traffic Manager:

- 7+ years in Air Traffic Control
- Efficient with time, task management, and communication.
- Familiar working with text based systems rather than graphical/visual based
  - Would be difficult for user to transition to new interface
  - Have preset approaches when observing AFP, quicker to push out FCA and FEA

### 7+ years in Air Traffic Control

Air traffic managers come from diverse backgrounds. While some have previous experience as pilots and or in the military, others may enter the field with limited experience. They generally begin as air traffic controllers, but may take different routes to become managers. These routes could be going directly to the manager role or into specialized positions (supervisor, instructor, specialist) before becoming a manager.

### Efficient with time, communication, and task management.

As an air traffic manager, relaying information such as airspace flow programs (AFPs) in a timely manner is a core component of their position. Being efficient with communication plays a large role because AFPs may not suit current conditions at a specific location. This makes time management essential being an air traffic manager, as they have to be considerate of limitations and flexible to adapt AFPs.

### Familiar working with text based systems rather than graphical/visual based

With the Federal Aviation Administration being a government institution, systems and hardware go through a strenuous procedure to be updated and ensure reliability. Current air traffic management systems rely heavily on text based user interfaces, but modern systems are more visual, using graphics and icons with text. With the usage of text based interfaces, there is a heavy amount of cognitive load, reducing efficiency when completing tasks compared to using a hybrid of text and graphical interfaces.

## 3.3 Users

### ATCSCC manager/users

- Flexibility to create FEAs and FCAs
- Approve and oversee national airspace

- Create AFPs that affect multiple regions

Regional Center manager/users

- Similar responsibilities as managers at ATCSCC
- More limitations when it comes to authority/control

### 3.4 Use Case

There is an abnormal weather pattern building up in the southeast of the United States. Multiple traffic management initiatives are being coordinated to anticipate the conditions and air traffic managers at Air Traffic Control System Command Center (ATCSCC) and regional facilities that will be affected are preparing to create an airspace flow program (AFP) to address the anticipated limits to traffic. All interested parties join a webinar to discuss needs and limitations within their regions. Using the FMDS dashboard managers are able to adjust the display of the map (zoom in and out), view future different time periods of the forecast (live, future, and previous), and filter what is shown on the map (FEAs, FCAs, aircraft types, etc). From the main dashboard page, the user launches the FEA flow. Coordinating with other centers they set up the FEA to capture all the flights that will move through the problem area. Later in the day an alert pops up warning that the number of aircraft moving through the Florida FEA will exceed the maximum number of allowed flights at 5 pm. They use the previous FEA as reference and adjust the AFP to different centers' needs. With the weather system dying down, the AFP is removed.

#### Use case application for Persona

This use case demonstrates the persona of an air traffic manager by displaying expertise and understanding coordination of air traffic control systems. They are efficient communicators, completing tasks in a timely manner and coordinating with multiple regional centers based on their needs to create/adjust AFPs. With experts being familiar and efficient using the tools they have been using for years, transitioning to newer systems would take some time to adjust.

#### Use case application for ATCSCC manager/users

The use case demonstrates the full extent of what an air traffic manager is able to do at the ATCSCC level. They are able to coordinate with other regional centers and have the authority to make broad changes to fit other centers' needs. The use case highlights the ATCSCC manager's abilities by demonstrating the collaborative efforts of making and adjusting AFPs.

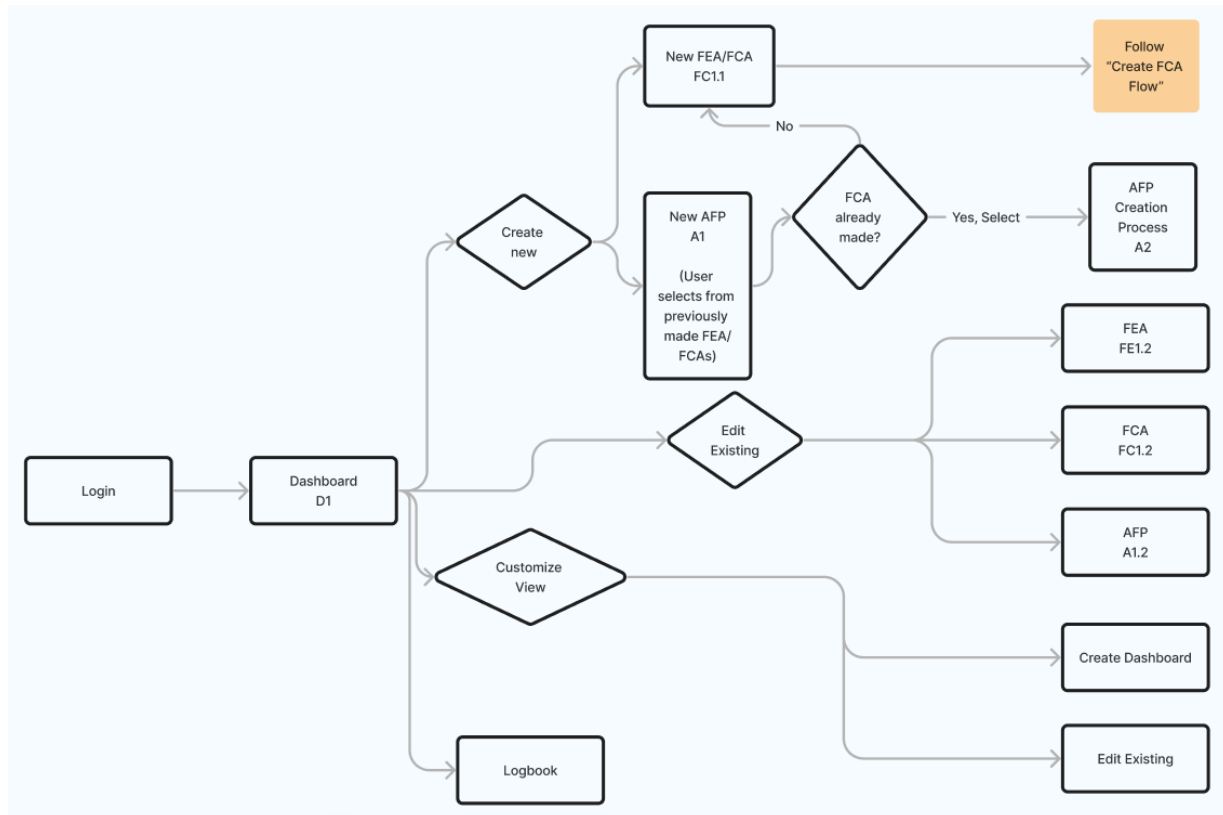
#### Use case application for Regional Center manager/users

The use case demonstrates the regional center manager's perspective by being on the receiving end of the ATCSCC's AFPs. Once the regional center's manager receives the AFP, they need to make adjustments and report back to the ATCSCC if there are any complications or adjustments that need to be taken. This presents limitations with the regional center's systems because they have to report back to the ATCSCC if adjustments from the regional area interferes with neighboring regions.

### 3.5 Flow Chart

Flow charts were created to help visualize the process of creating and navigating the necessary functions of the prototype. To emphasize the depth the team took to consider flow management of an air traffic manager, three flow charts were created to demonstrate the flow of the dashboard navigation, creating/editing the FEA/FCA, and creating the AFP.

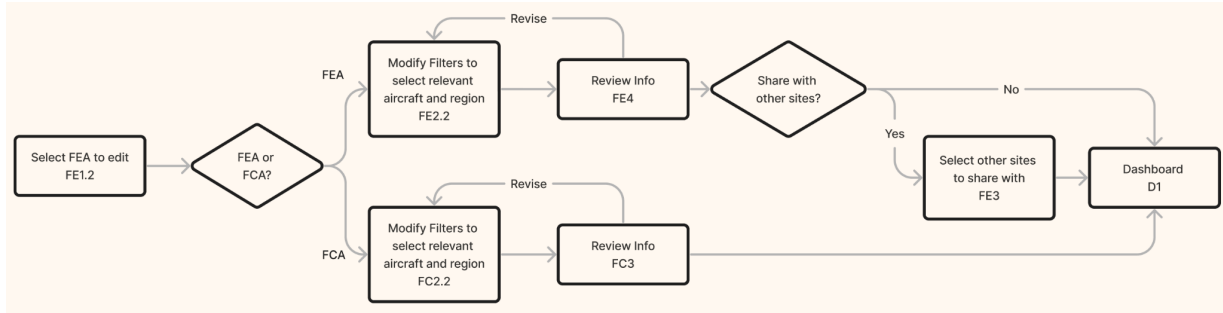
We focused on mapping the flows directed towards and between flow evaluation area (FEA)/ flow constrained area (FCA) and airspace flow program (AFP). This is owing to the fact that an FCA prompts a mandatory action once it is created, as an Airspace Flow Program or other traffic management initiative (TMI) is necessary to ensure the number of aircraft in the defined area does not exceed the set limit. Some of the actions defined in the flowcharts are redundant, owing to the fact that the same function may be started in a number of different ways from different starting points. This is intentional, and again reflects the different workflows various users may default to or prefer.



Dashboard Navigation Flow

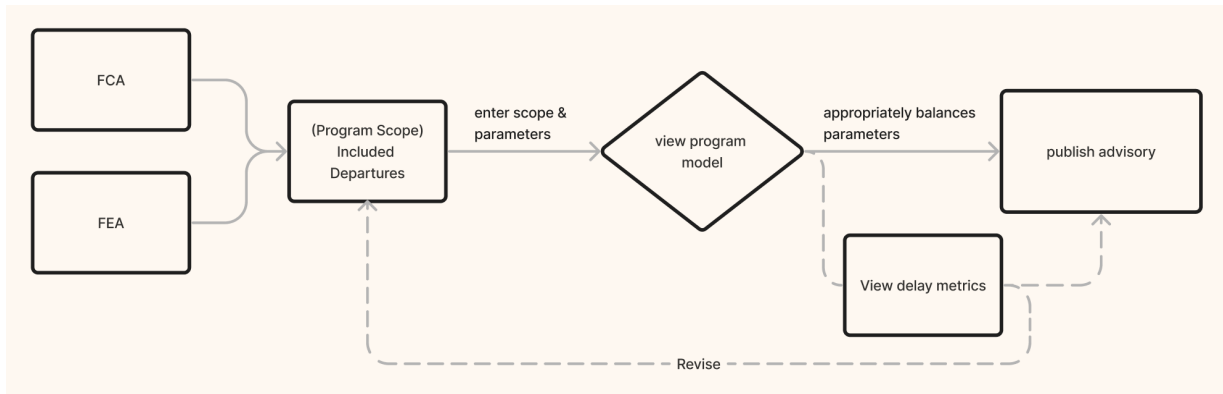
After logging into the dashboard, users are given the option to look through the logbook, customize the dashboard, edit existing iterations, and create new FEA/FCA and AFP. The logbook is used to keep account of actions taken throughout the usage of the system. To customize the dashboard, users are able to make visual modifications to suit users needs. Editing existing iterations and creating new FEA/FCA and AFP go further in depth in individual flow charts.





### Create/Edit the FEA/FCA Flow

Creation/editing of FEA and FCA were integrated in the same flow because they follow similar navigation. Both FEA and FCA have a function to review and revise before navigating to the dashboard. A key difference is that the FEA allows for shareability with other centers.

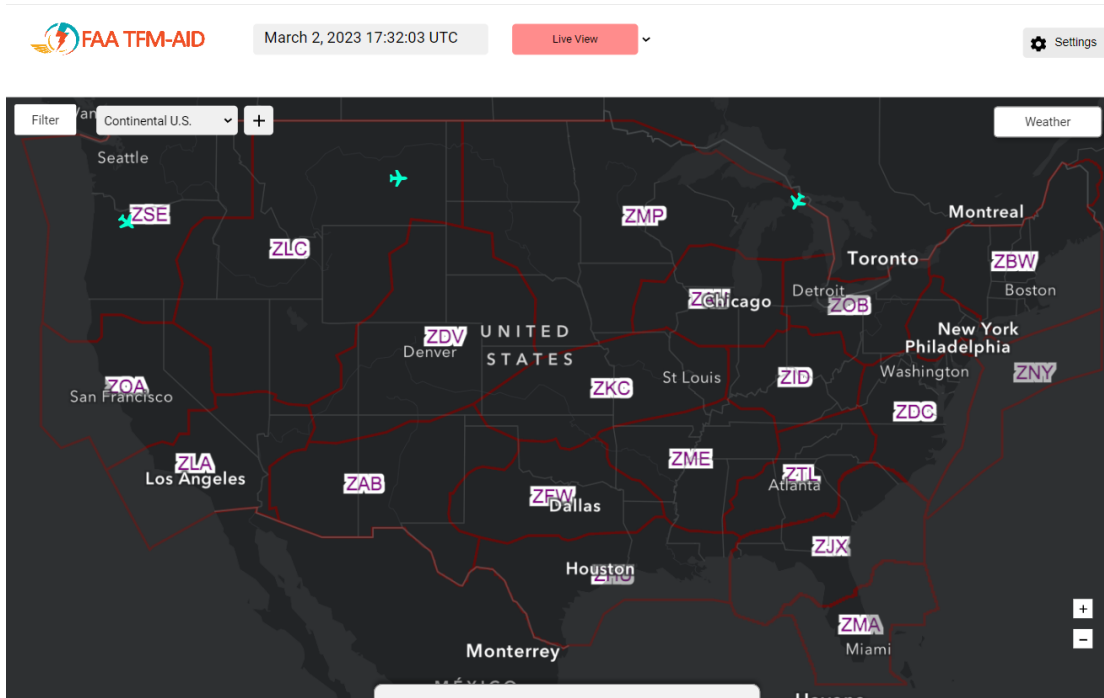


### Create AFP Flow

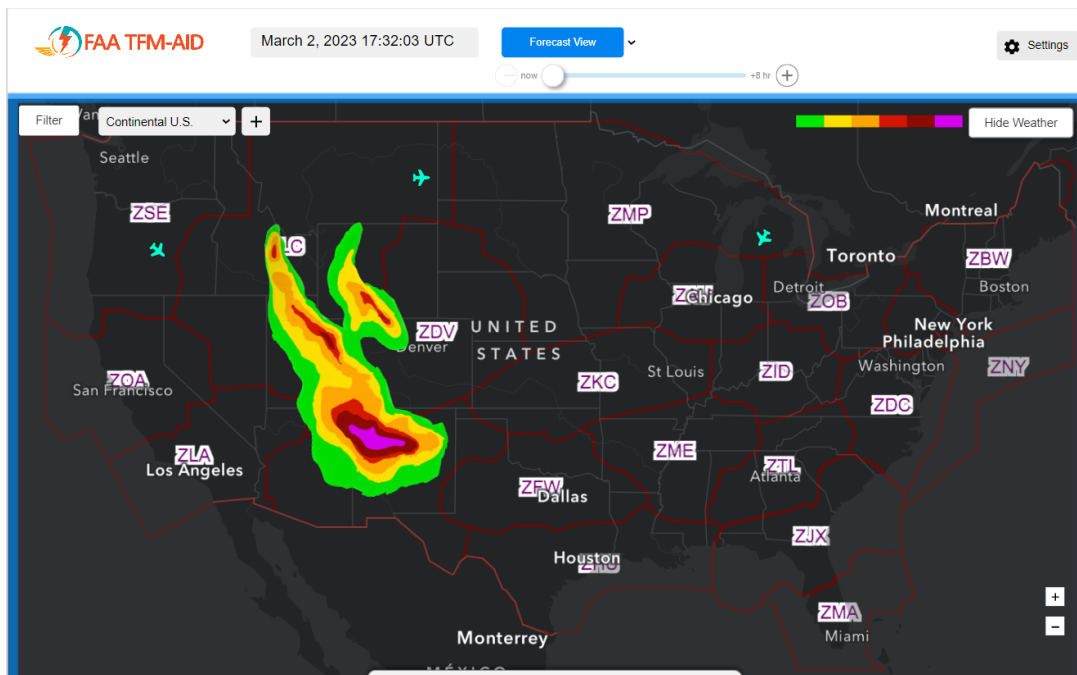
After selection of an FEA or FCA, users are led to the creation of the AFP. Users are able to implement parameters that suit current conditions affecting air traffic flow. Once drafting the AFP, users are able to make further adjustments to balance parameters and view delay metrics through revisions. When the AFP is ready, it is published/sent to regional centers and other parties requiring the AFP.

# 4 Final Prototype

## 4.1 Main Dashboard



Dashboard Live View



Dashboard Forecast View

Our final prototype has been revised to focus on a single monitor layout, with the intention that it can be expanded to two monitors when available/desired. The primary view of the dashboard centers on a live map displaying current air traffic, weather, and FEA/FCAs that are relevant to the user. By utilizing the filter functions, users can customize their view, and different map view options can be saved as “presets” such that a user can select a preset and have the map adjusted to show the part of the U.S. they want, with their preferred filters. All aircraft, regions, and FEA/FCAs would be interactable. Clicking on any of them would result in a popup window which would include relevant information about the item they had selected.

A second major function of this primary dashboard view would allow users to look forward in time. By toggling between a “Live View” and “Forecast View” users would then be able to look at points in time and see the projected air traffic based on filed flight plans, as well as predicted weather patterns. This would be helpful for visualizing FEA/FCAs that may be needed and their associated TMIs. We recognized in our design the importance of making it visually clear at all times when a user is not looking at a live display. To mitigate this, we have added a colored banner that will be visible and blinking at all times when a user is in “Forecast Mode”. When returning the “Live View” this banner would go away, and the aircraft and weather systems would return to their live display.

In the single screen format, a bottom bar of options would also be accessible on the screen, although users could minimize it if they did not want to see it. In a two screen format, all of the functions contained in this navigation bar would be housed on the second screen.

For accessing and reviewing previous events, users would navigate to an Archive function within the settings menu. This menu would also allow users to logout and toggle between a day and night view, depending on their screen preferences. Other functions not captured in the scope of this brief could also be added as necessary.

## 4.2 FEA/FCA

The image displays two screenshots of the "Create FEA/FCA" interface. The left screenshot shows the "Parameters" tab, which includes fields for Name, Time Range (Start and End Time), Altitude Range (Ceiling and Floor), Moving Parameters (Heading and Speed), and Characteristics (Type and Domain). The right screenshot shows the "Primary Filter" tab, which includes options for Polygon, Line, Circle, and NAS, and a list of filter conditions such as "Departs from any of", "Traverses any of", and "Heading is within". It also includes sections for Flight Level, Aircraft Category, RSVM Category, and User category.

For the FEA/FCA design we preserved all the functions in the existing wizard, as these are necessary for the tasks, but modified them to be interactive and to improve the visual design. We have incorporated the lat/lon filter page and the shared sites page as expandable options from the primary parameters page that would expand the dialogue box when the user selects a shape or picks the “shared” domain. This accomplishes two things. By grouping related tasks together the user does not need to click back and forth between pages to accomplish one task, and by presenting the information in one place, the user does not need to rely on their memory, and can visually confirm the information they need.

To make the visual layout cleaner and to reduce visual clutter, in the characteristics section we separated the domain and type options in a vertical format, and created a shared sites tab on the parameters screen. On the primary filter and secondary filters, users can now manually select the filter tools they want to use. The “add filter” function allows them to choose from a droplist which filter they want to use. By only adding the filter options they need, rather than having all the options displayed, the visual layout is much less busy. We changed the filter page, separating the six different flight highlighted levels and reorganizing the array of checkboxes. For the Primary filter tab, we mainly updated the bottom half of the dialog box to give the options more space and clarity. While doing this we applied the concepts from Fitts Law, which predicts movement and assesses the time it takes to get to the target in regards to the size of the target (Fitts, 1954).

Across the FEA/FCA flow we have replaced many of the checkboxes and radio buttons with larger buttons. In line with Fitts Law, the intention is to reduce the time needed to select specific options, by making the interactable window larger. While the individual gains in this change are minimal, they do add up over time, especially by reducing the likelihood of a user needing to click on something multiple times to successfully select it.

### 4.3 AFP

**Program Time Options**

Choose a Time Range

Start Time: 2:17:36      End Time: 4:47

Date Time: 02:17:36

**Purge Flights**

Before Revision Start

Compress to Last CTA

After Revision End

**Program Rate (Applicable only to included flights)**

Load Times      Load ADL AAR      Historical Pop-Ups

Fill:       With:

From Hour: 8 : 21 PM      Within Hour: 8 : 21 PM

Interval (minutes):  15     30     60

Rate	14:00	14:15	14:30	14:45	15:00	15:15	15:30	15:45	16:00	16:15	16:30
PR	10	10	10	10	10	10	10	10	10	10	10
Pop - Up	0	0	0	0	0	0	0	0	0	0	0
Reserve	-	-	-	-	-	-	-	-	-	-	-

AAR       Set AAR to Program Rate       Retain Current ADL AAR

**GDT Map**

For the AFP we created a pop-up screen that consisted of scope, parameters, and modeling options. Once the data is entered by the user, the model will then be compiled and shown. Allowing you to make changes to the scope, parameters, and modeling options as needed while having access to view the model. The pop-up modal reduces cognitive overload as the user now has access to more visually appealing screens with interactive material making it more intuitive and quicker to input. It lets them concentrate on the tasks at hand without any distractions. According to our eye tracking movements from previous experience, users tend to read or browse from left to right. Hence, everything is left-aligned except for the important features. On the scope screen, the “select all” feature is left aligned, for the user to see the function better. Everything on screens are labeled, so users can recognize rather than recall the components on the screens.

For the parameter’s screen, we used Gestalt’s principle of closure to make the elements actionable and stand out (Wertheimer, 1920). According to the principle, components that are grouped together tend to be perceived by us humans as one component that shares similar elements. By applying the principle, we improved the time slider by making the main element on the top half of the screen and easy to slide for the desired time. In addition, users can edit the timings through inputting hours and minutes. We changed the UI elements of how time is displayed. The UI element for time follows the user's mental model of the digital clock, similar to phones and laptops. On the bottom half of the pop-up, the table is partially edited with a tabs experience, allowing users to toggle between the 15, 30 and 60 minutes. The rate changes accordingly and users are able to edit PR, Pop-UP and Reserve. We preserved the table in a horizontal orientation to assist the user's mental model. Above the table, we

added a time picker for “From Hour” and “Within Hour” to ensure users do not miss the choices. We made this change because recognizing is easier than recalling information. From previous experiences, users have an easier time with time picker visually and make fewer mistakes than using the drop list.

## 5 PDR to CDR

### 5.1 Actions and Recommendations

PDR Concerns	Resolutions
<b>General</b>	
Possible integration of chat feature.	After consideration, a chat feature was not added due to increased cognitive load with the addition of having to communicate with visual text.
Customization colors.	Color customization was integrated in the custom view section. Users are also able to switch between normal view and night mode.
Retained the feel and behavior of the current system very well. Reducing static data entries as in today's system is desired.	Applied current design principles to modernize the visuals and increase efficiency of usage.
Need to proofread and have visual aid for readers through organization.	A table of contents was added to aid readers navigating the report. Page numbers were implemented so readers are able to refer back to pages if needed. Additional title headers and borders were added to distinguish certain sections.
Gaining insight through interviews or usability tests would be a great opportunity to understand challenges of air traffic management.	Interviewed and presented the prototype to professionals in the FAA and NASA.
More graphics used in the report.	More images were added to support visualization of the prototype.
<b>Dashboard</b>	
Concerns about visibility of Live/Not Live modes.	Changed language from “Not Live” to “Forecast View”. Improved visibility with highlighted blinking banner on map to remind viewers that currently displayed data is not live.
Would like to see more about how the user manages	Tabs were incorporated into the screens.

screen use, workflow through the application, and making sure screen space is still available for other use.	
Justify significance of the “LIVE” feature.	The “Live” feature allows users a second perspective of reference when observing time.
FEA/FCA	
More development of FEA/FCA dialogue boxes needed	Further development of FEA/FCA and AFP dialogs to reduce work and make visually cleaner.
Concerns about functionality within the constraints, specifically display size	Increased focus on functionality with a single screen view. Application can now be housed entirely on one screen if needed
User/Persona	
Persona is missing from the project.	Persona has been added and user groups defined, presenting general information about an air traffic manager.
Include a use case.	Use cases have been added, demonstrating how an air traffic manager would use these systems.
Video	
The video seemed to end abruptly; it would have been wonderful to put names to the smiling faces!	Names were added in the image displayed at the end of the video to associate team members and faces.
Video was informative but exceeded 2 minutes. Be mindful of submission requirements.	Video for the CDR submission is inline with time restrictions.
Other	
Browser based vs application based implementation feasibility.	The team chose to focus primarily on the application base prototype so there would be one good product, rather than holes in two separate systems.

## 5.2 Main Dashboard

On the main dashboard we added the drop down menu where you can decide on the area you're looking at, so it can be associated with the map option you are currently viewing (ex: U.S. Continental). The date and time were moved onto one line, and the forecast view was changed to a dropdown list that defaulted on the “LIVE” view so these options are easily accessible to the user. Since the settings feature isn't expected to be used as often, it has been moved to the upper right corner of

the screen. Also, to increase intuitiveness, we took the weather feature out of the left vertical menu and posted it on the main screen in the right corner of the map. In regards to the map, it can be made interactive by selecting a specific area, like a state, and a pop-up will appear for that location that displays data such as traffic. The bottom of the map now has a horizontal bar that displays actionable elements that may be of use to the user at certain times.

Color customization: We have decided that the option for color customization should not be included in the prototype. As people would be sharing screens and looking at the same information, it is important that the display of that information be consistent for all users to prevent confusion. Color options to assign to FEAs would come from a present list, and once selected would not be changed.

The one exception for this would be for accessibility purposes for users who may be colorblind or prefer a high contrast view. Backend coding would correlate all colors in use between a full color and colorblind view.

### 5.3 AFP

The AFP has been adjusted by creating separate tabs for the scope, parameters, and modeling options. The original dialog layout has been changed in order to be more interactive, intuitive, and simpler for the user.

When accessing parameters, the slider had been adjusted to better represent the time range being enforced. Functionally, the start and end time will be updated when using the slider. When changing From Hour and Through Hour, times on the table would be updated accordingly to reflect the changes from the dropdown.

Observing the scope, users are now able to sort out exempt and nonexempt on a side by side panel. When observing airspaces in the non-exempt category, users are able to implement notes that can be viewable when hovering the airspace. Navigating to the modeling options, the main change was the addition of semicolons to the displayed time to differentiate between hours, minutes, and seconds (EX. 10:00:30).

### 5.4 FEA/FCA

The share site is no longer an individual tab in the dialog box and has been converted to a side popup function once the “shared” domain is selected. When presented with shared spaces for the shared function, users can add more sites, rather than displaying all sites previously. Radio buttons are no longer used and have been changed to selection style group buttons.

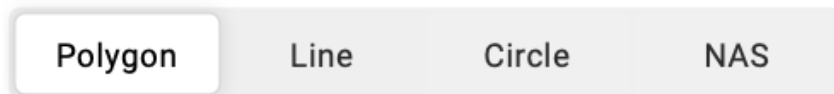


Figure. 1 Selected Button Updated

Latitude and longitude has been implemented into parameters as a side popup rather than a separate tab while retaining the original functionality. Instead of displaying all filters simultaneously, the



interface now has a dropdown menu that lets the user pick relevant filters for both primary and secondary filters to avoid clutter in the visual space.

Preferences to select the visible and selected time range have been updated from the previous design to a slider so the user has a visual representation of the limits for both minimum and maximum.

Originally the recall FEA/FCA dialog box only provided the name of an FEA/FCA instance, leaving the user to retrieve specifics from memory. Now there is a side popup that provides parameter details of a previous FEA/FCA to help facilitate the user in remembering information accurately. This uses the principle of recognition over recall.

Orientation of FEA/FCA data presented on map is reoriented, allowing for better readability. Displayed shapes are now dynamic, allowing users to visualize speed. This had been done by displaying shapes with bigger gaps in the gradients as faster movement. Dialog box parameters can be created directly on the map, rather than using the dialog box, to adjust a FEA/FCA after drawing on the map.

## 5.5 Flow Chart

Flowcharts were adjusted to better represent the flow and navigation of air traffic managers. For the dashboard navigation flow, a logbook was implemented to recall previous actions taken when using the system. For the custom view, flows were extended navigating to options of creating and editing the dashboard display. Flow of editing existing was also elaborated on, navigating flows to previous FEAs, FCAs, and AFPs. In the PDR report, FEA and FCA were separated and were updated to be combined in the same path due to having similar flow navigation. Terminology for AFP “Wizard” was updated to “Creation Process”, allowing for clearer title distinction.

For the Create/Edit the FEA/FCA flow chart, FEA and FCA were combined into one flow (previously two separate flows). Instead of being led directly to the creation of an AFP, users navigate back to the dashboard. This was to allow further options to the user, rather than having them create an AFP directly after finishing an FEA or FCA. Sharing function was added to directly send FEA to other interested parties. Review and revision flow was implemented to visualize the option to make adjustments at the FEA or FCA navigation if necessary. For creating an AFP, the flow was previously accurate and did not need further changes.

## 5.6 Other Updates

### Browser vs Application Based

When considering applying the prototype to different systems, our team chose to stick with the application based, rather than orientate the prototype to both systems. This decision was made due to the consideration of quality when completing the prototype. The team chose to focus primarily on the application base prototype so there would be one good product, rather than holes in two separate systems.

### Chat Feature

After consideration, a chat feature was not added due to increased cognitive load with the addition of having to communicate using visual text. Previous justification for the text based communication was having a secondary reliable way to transfer information. The usage of the share feature and verbal communication is adequate enough to transfer information without disrupting the workflow of the user.

## 6 Project Schedule ---

Date	Description
<b>March 9, 2023</b>	<b>Preliminary Design Review (PDR) Package Submission Deadline</b>
March 30, 2023	Teams Notified of Selection Status
April 20, 2023	Complete Persona
April - May	Additional research
May 1, 2023	Start prototype iteration
<b>May 17, 2023</b>	<b>Deadline for registration and payment to forum</b>
<b>May 26, 2023</b>	<b>Deadline for hotel reservation at group rate</b>
May 31, 2023	Complete Prototype
<b>June 1, 2023</b>	<b>Prototype Video</b>
June 5, 2023	Complete Critical Design Review
<b>June 7, 2023</b>	<b>Submit a Critical Design Review (CDR) package</b>

## 7 Prototype and Video ---

### 7.1 Prototype

Prototype Link: <https://nnmvq6.axshare.com>

### 7.2 Video

Video Link: <https://youtu.be/oKOMaBMeval>

## 8 References

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