

aMaize: A Unified GUI for FMDS

Critical Design Review

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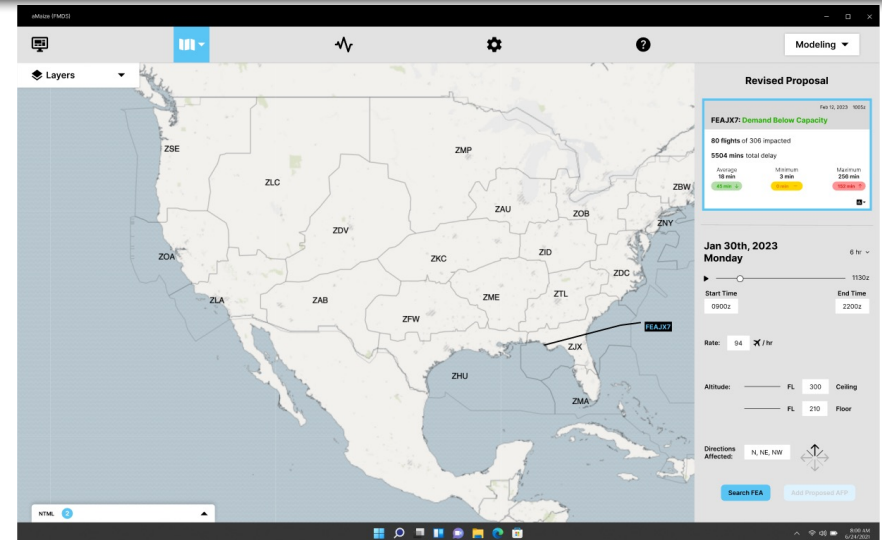
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University of Michigan: aMaize – A Unified GUI for FMDS

Project Description / Requirements

aMaize is a unified interface for Traffic Managers to work with AFPs while spotlighting collaboration and customization

- Centralized workflows to minimize repetitive and tedious tasks
- Intuitive, user-centered visual design to reduce user training
- Customization to adapt to different user roles and AFP workflows
- Collaboration Feature to enhance cross-facility strategic planning and information sharing
- Automation-assisted logging to decrease user burnout from documentation



Risks / Issues

- Users may abuse the chat feature (non-work related threads, sensitive language, etc.)
- Security concerns if web-based development is preferred
- Users may have a difficult time adjusting to the new interface due to drastic differences in design from the current TFMS interface

Next Steps

1. On-boarding mockups to walk through interface, definition of new colors, and icons for first time users
2. Modifying bar width in FSM graphs to display 8-12 hours of data simultaneously
3. Perform further user testing to uncover pain points and usability issues
4. Including an airline view and consider developing airline-specific features, particularly for viewing FSM graphs
5. Collaborate with software developers to determine feasibility of design and make design tweaks accordingly

Response to TFM-AID Judges' Reviews

This section addresses feedback on our PDR submission from TFM-AID Judges, which include representatives from the FAA, MITRE, and Mosaic ATM. Feedback from judges is in black, while our team's response is in blue.

(R1) - The current system already has a built-in voice capability. Incorporating a chat feature would be a change in current workflow. This avenue could be worth further exploration to determine its effectiveness; convince us if you see value and how it could be used.

Response to (R1): From user interviews with former ATCSCC Traffic Managers, we learned that phone calls are frequently used, and there is a desire for chat communication as well. As a result, we've developed a new collaboration tool that integrates voice and chat communication.

(R2) - User customization of colors is beneficial but also a risk factor, give serious thought on how much you want to allow users to customize colors and if so, what controls and guidance is involved.

Response to (R2): We have clarified which colors are customizable: plane color on the TSD-style map and notification colors from NTML, as well as our collaboration tool. Colors on data cards are not customizable. This addresses the risk factor mentioned in our PDR.

(R3) - Did you do the survey?! That was a very nice touch, but I did not see it mentioned in the body of the text or did I miss that?

Response to (R3): We did not receive any survey responses. Our team focused on user interviews, which allowed us to deeply understand user needs and frustrations. With a longer project timeline, a survey would have been more feasible and would have allowed us to categorize users.

(R4) - The data cards pull a lot of information nicely together. Would be nice to somehow give a little bit of that to the map as well - not sure how, but that would be nice.

Response to (R4): We now include a data card directly adjacent to the map. In addition, the FEA/FCA line referenced in the data card is labeled and displayed on the TSD-style map. These changes unify information summarized in the data card with visual representations on the map.

(R5) - Splitting the AFPs, etc. to a second display also splits the user's attention between the two displays. It would be nice to reduce search time by providing a way to indicate on the other display which object is selected (e.g. on the map when selecting details on the secondary display).

Response to (R5): To improve the connectivity between the two displays, we included a data card with corresponding input parameters on the left monitor that directly correlates to the selected data card on the right monitor. There is a blue border around both data cards to show it has been selected, and the interface will update accordingly if the user selects a different data card.

(R6) - Showing your design tool and not just the screen designs does not make for a good demo.

Response to (R6): Since the PDR, we've finalized our screen designs and made an interactive prototype of our design tool.

(R7) - Keep in mind that the bar graphs need to represent time well beyond the 4 hour range of the TMI you are showing as that a TMI will delay flight past the time range of the TMI.

Response to (R7): We now allow the user to see up to three days in advance of the current time on the bar graphs. Users can use toggle buttons to go forwards and backwards in time. Additionally, users can select which date they are viewing data for. Our next step is to shrink the width of individual bars to show 8-12 hours simultaneously without the need to toggle.

(R8) - Would like to see how you'd include airline operators in the process since you have already made contact with them. (For example, how do you see an airline participating in this application?)

Response to (R8): Since our PDR, we've conducted interviews with Delta's Operations and Customer Center (OCC), which are users of TFMS applications. Delta's OCC voiced strong interest in our application and we believe that airline operators will be participants in a limited version of aMaize (outlined as a next step). Airline operators, for example, are unable to approve restrictions in NTML.

(R9) - Seem to have a lot of empty/white space, is there a possibility to better consolidate so that not both monitors are tied up with AFP work and one could be used for other issues the traffic manager is focusing on?

Response to (R9): Our wireframes have been designed with the collaboration tool visible. If users require more space, they are able to minimize the collaboration tool. While "Monitoring", NTMS can view multiple issues simultaneously using the Multi FSM Plot View button . When data cards are visible on the right monitor, NTMS can select Remove Card(s)  to clear space.

(R10) - Would like to see more about how user manages screen use, workflow through the application, and making sure screens space is still available for other use.

Response to (R10): Since our PDR, we've given users more control over how they manage screen use. For example, users can easily remove data cards via a "Remove Card" button and minimize the collaboration tool, which frees up one entire monitor for other use. This user workflow has been demonstrated via our interactive prototype.

(R11) - Please discuss browser based vs application based implementation feasibility.

Response to (R11): Based on our discussion with NASA, who have developed applications for the FAA in the past, we believe that both browser-based and application-based implementations are feasible. Although an application-based solution is more secure, browser-based implementation is easier to develop/maintain via software updates and distribute to other facilities which are users of FMDS. From our interviews, multiple industry stakeholders advocated for a browser-based application.

(R12) - The shareability of modeled information is a critical challenge in coordination. Ensuring my "data card" matches another TM's "data card" is more critical than whether colors are compatible.

Response to (R12): We've developed user interactions which show how to easily share modeled AFPs. After modeling an AFP, the user can click the share icon on a data card and choose which chat thread to share the data card to. The user will then see the data card inserted into that chat thread. The sender and the recipient will see the same data card with matching colors.

(R13) - One concern I have in general is about how you are going to connect the data cards to the visual representation of the FEAs, FCAs, and AFPs. You are not alone in that, but it is a concern.

[Response to \(R13\):](#) Thanks for your feedback. We believe our responses to R4 and R5 address this concern.


(R14) - Would like to know more about the chat feature and see how it is integrated into the workflow.

[Response to \(R14\):](#) Based on our user research, we've developed a collaboration tool that organically integrates chat and voice communication. On the right side of the right monitor, users can find the collaboration tool with different threads. Within each thread, users can message each other and share data cards, or join the voice room to speak with other members in the thread. More detailed discussion of this collaboration is in the "Product Features" section of our report.

(R15) - When an AFP is implemented, a notification is displayed above the NTML icon to alert users of a change to the NAS. What does this look like? The chat feature more than likely will be distracting. Also with the chat feature, will the communication will be automatically saved for record keeping purposes.

Just a note: TMO should be replaced with National Traffic Management Specialist (NTMS)

[Response to \(R15\):](#) Since our PDR, we've changed the placement of NTML and redesigned how notifications are displayed to minimize distractions. NTML now rests in the bottom left of the left monitor. When a notification is pushed to NTML (i.e. when an AFP is implemented), a blue circle appears with the

number of new notifications . *Early user feedback shows that this is an effective and subtle way of alerting users to changes in the NAS. We would also like to highlight that NTML and the collaboration tool are two distinct features: the collaboration tool enhances collaboration within the FAA throughout the AFP creation process.*

(R16) - How did you use the persona that you developed to create and validate your design? What would "Kristin" think of your design proposal considering her priorities and background? Does it address the issues she has with the current system?

[Response to \(R16\):](#) Every design decision is driven by our user research. Our early user tests show that our product is user-friendly and encourages collaborative decision making (CDM). Needs of the user persona are addressed in our user story.

(R17) - The video seemed a bit cold and rehearsed. The user story in your paper was excellent and I think that putting yourself in a traffic manager's shoes and approaching your video/presentation with a storyline could help improve your overall package.

[Response to \(R17\):](#) Thank you for your feedback - our CDR video is based on a user story.

(R18) - For the report, a table of contents and some additional structuring would have made for an easier read/navigation of the document. A wrap-up/take-aways/final thoughts would indicate to the reader that the paper is completed

[Response to \(R18\):](#) We have included a table of contents and provided additional structure.

(R19) - While the degree of customization planned is a good idea, consider standardizing the colors or at least noting that there should be some recommendation standard. This would eliminate a risk you've highlighted multiple times and prevent challenges in future user training.

Response to (R19): We've clarified which parts of the interface are customizable and have included a default color palette with good contrast so objects are easily distinguishable from one another.

(R20) - Recommend creating an additional user persona to account for a long-time user.

Response to (R20): Since the PDR, we have adapted our user persona to account for a long-time user. Upon discussion, our team found that when being introduced to a new technology, there are many similarities in the needs and goals of new NTMSs and new FMDS users who have worked in the Command Center for years.

(R21) - Discussion of segmented AFP strategy is unclear. It is mentioned as needed but not whether anything will be done about it.

Response to (R21): We've designed user interactions to demonstrate how a segmented AFP strategy can be used in aMaize. These additions are demonstrated in our CDR video.

(R22) - Recommend not describing the tool as "easy-to-use." While that may be true, that's a goal that's in the eyes of the user rather than an objective descriptor.

Response to (R22): We have modified our report to only mention such descriptors when users described our product in this way during user tests or user feedback.

(R23) - You showed more detail of the drawing feature in the video; would have been nice to include that in the report as well.

Response to (R23): Due to space constraints, we opted to demo the drawing tool in our video because it involves multiple screens and can be better explained via video.

SUMMARY

aMaize - A Unified GUI for FMDS is an intuitive interface that streamlines the Airspace Flow Program (AFP) workflow for Federal Aviation Administration (FAA) National Traffic Management Specialists (NTMS). The Graphical User Interface (GUI) was developed for the FAA's new automation system, Flow Management Data and Services (FMDS), and was designed to address the pain points provided by Traffic Management Specialists, minimize user training, and strengthen collaborative decision making. From our user research, we developed three core functionalities, which are summarized below:

- **Evaluating** - Evaluate AFP need via weather overlays on an interactive map, visualize demand-capacity imbalances with metrics and a revamped Flight Schedule Monitor (FSM) graph, and recap National Airspace System (NAS) constraints via a "Constraints Summary"
- **Modeling** - Input parameters to model different AFPs, see delay metrics and AFP impact at a glance, quickly determine if a proposed AFP addresses a demand-capacity imbalance, and easily share AFP models with facilities. After collaboration, schedule or implement an AFP immediately, with an update automatically pushed to the National Traffic Management Log (NTML)
- **Monitoring** - View the implemented AFP(s) and multiple Flow Evaluation Areas/Flow Constrained Areas (FEAs/FCAs) at the same time, track AFP revision history, and revise AFP(s) as needed. Purge an AFP when it is no longer needed, with an update pushed to NTML

aMaize was designed to help make NTMSs' workflow more efficient, make collaboration easier, and ease the burden of documentation. Our interface accomplishes this by:

- Integrating currently separate applications to reduce repetitive inputs and streamline workflows
- Creating a collaboration tool to strengthen collaboration and coordination across facilities
- Structuring and automating NTML logs to help reduce user-provided free text, which has been identified as a source of burnout




Our interface, in combination with FMDS, is designed to help NTMS' complete their tasks more efficiently. With *aMaize*, NTML and action logging is more structured and accurate. The software detects details of the user's actions (e.g. AFP start and end time), and uses this information to automatically push an update to NTML in a consistent, structured log entry. New icons and logs grouped by topic make NTML easier to interpret, improving cross-facility coordination. User training is improved through a more intuitive interface and adherence to user experience (UX) design principles. By modernizing and unifying the feel of the interface, with usability driving every design decision, new users will feel less overwhelmed during the onboarding process. To adapt to varying user needs, our GUI enables customization of what information is displayed and how it is displayed. This adapts the interface to suit the user's needs, no matter their role.

Since our PDR submission, our team further engaged with FAA personnel, airline operators, and industry stakeholders such as NASA and Mosaic ATM. Using these more comprehensive user insights, we refined our three core workflows, developed a collaboration tool, added a "Dashboard" View to provide NAS-wide updates at-a-glance, and further developed our automation-assisted NTML feature. Results from our user tests with former FAA Traffic Managers and Delta Operations Personnel were used to identify and resolve usability issues, while reinforcing that our product is thoughtfully designed and satisfies user needs.

PROJECT DESCRIPTION

Design Constraints

Our mockups are scaled up to 1920 x 1200 native resolution where we have tested readability on 24” monitors and ensured everything is readable from four feet away. Our mockups are displayed using two monitors, as we have found that certain functionalities, such as “Modeling”, “Monitoring” and the collaboration tool, are better-displayed with a dual monitor setup; the dual monitor will provide a more cohesive user workflow and experience. Our product never uses more than two monitors. If users require more space, they can now minimize the collaboration tool and remove data cards, freeing up the right monitor for other use.

aMaize users have multiple opportunities to customize the interface to best suit their role and workflow. The “Layers” tool  allows users to change what is visible on the map, and assists in distinguishing between different aircraft and vehicle categories. Color throughout the interface was intentionally selected — red, for example, alerts the user of something that requires attention. Users have the ability to change notification colors and the colors of planes and FEA/FCA lines on the TSD-style map via the “Settings” menu . Users can also create hotkeys to speed up how users access frequently used features. For example, instead of using the core functionalities drop-down menu, users can configure ‘control + e’ to launch the “Evaluating” screen. Further customization is seen with the preset capabilities ; users are able to create, set, and revise presets to recall preferred settings while “Evaluating” and “Monitoring”. In the collaboration tool, users have the ability to pin and mute chat threads, allowing them to minimize notification fatigue.

Understanding the User: User Persona

To design a human-centered product, understanding the user is vital. Our team dedicated time and resources to understand the user, including interviewing:

- Jen Ross, former Command Center and current Air Traffic Manager at Jacksonville Air Route Traffic Control Center (ARTCC)
- Ralph Tamburro, former N90 Supervisory Traffic Management Coordinator (STMC) and current Program Manager of Airspace Modernization at the Port Authority of New York and New Jersey
- Jason Connolly, former Digital Technology Manager at Delta Air Line’s (DAL) OCC and Bill Tuck, General Manager of Air Traffic Management (ATM) at Delta
- Other industry stakeholders including Curt Kaler from Mosaic ATM and NASA Human Factors Expert Eric Chevalley

Our team also researched TFMS slide decks and Traffic Flow Management (TFM) training videos.

Research Takeaways

From our research, we learned user needs and pain points with current TFMS services and user workflows, which are summarized below:

- Current interface is hard-to-navigate: There’s an overwhelming number of different interfaces, most of which do not communicate with each other, and add clutter and create user confusion
- Weather plays a big role in determining the need for an AFP, along with other NAS constraints
- Summarizing AFP impact (e.g. delay metrics, adherence to EDCT) helps NTMSs make informed decisions quickly
- Air Traffic Control System Command Center (ATCSCC) has a higher-level view than facilities (ARTCCs), and looks at NAS-wide constraints
- AFPs work in conjunction with other Traffic Management Initiatives (TMI)
- NTMSs may not log on NTML during peak workloads: They are too busy addressing the NAS constraint(s) to document it

- NTMS have to use multiple communication platforms rather than one, making CDM challenging and creating numerous occasions where NTMSs are left waiting for a response
- To start their day, NTMSs go to the NAS Status website to receive updates on the NAS, view active initiatives and reference the Ops plan, but view weather updates in a different location

Putting all of this together, we created a user persona for our primary user, a Traffic Manager at the ATCSCC, which can be seen in Figure 1 below.

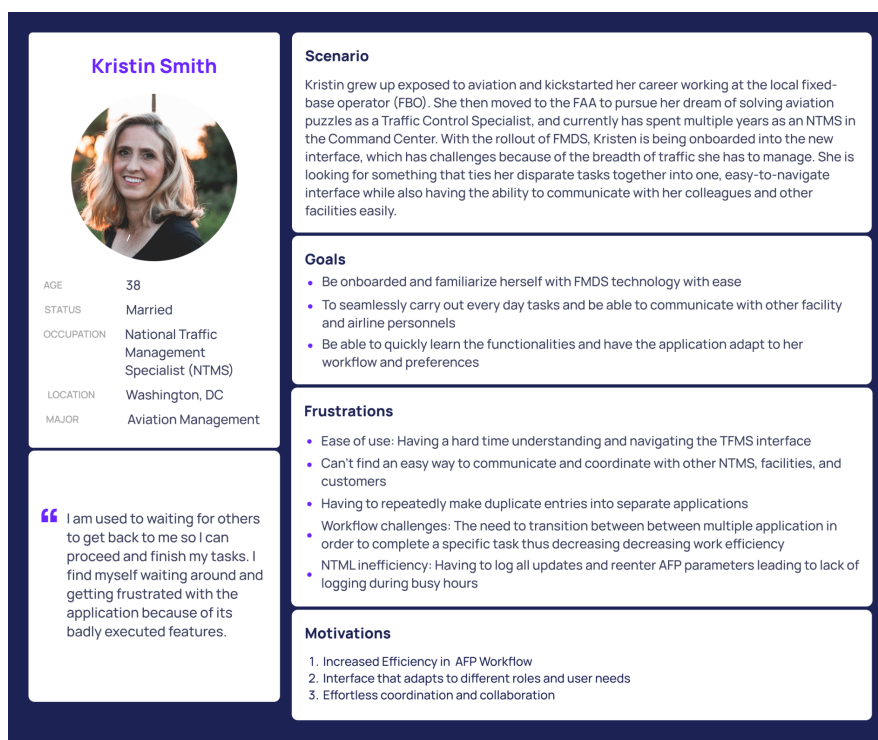





Figure 1: User Persona of aMaize's primary user, an FAA NTMS

Product Features

Based on the TFM-AID Challenge guidelines and our in-depth user research, we developed three core product functionalities: Evaluating, Modeling, and Monitoring. (Note: Since our PDR, we combined Creating and Canceling with Modeling and Monitoring respectively, as we found these workflows are closely intertwined).

Evaluating

When evaluating the need for an AFP, NTMSs must determine whether there is a demand-capacity imbalance. Users either draw FEA/FCA lines with the “Drawing Tool” , or select a pre-existing one through our “Map” tool  on the Global Navigation Bar. FSM graphs and metrics for the FEA/FCA line are populated on a data card on the right monitor, allowing the user to view any demand-capacity imbalance. On the right side pane shown in Figure 2, there is a “Constraint Summary” allowing the user to view routes impacted by NAS constraints. A slider allows users to view ± 8 hours of the current time. Dragging the slider will update the map instantly. Users can modify the time range shown on the map via the drop-down menu . Since the PDR, we've made enhancements to improve contrast on the map, such as removing the purple fill color when ARTCC lines are displayed.

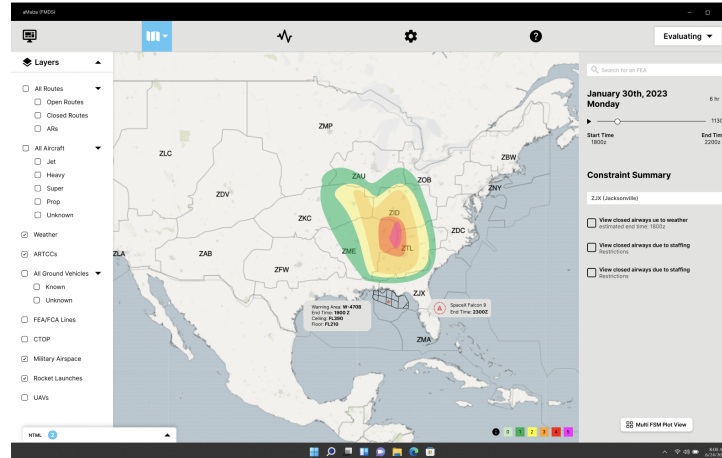


Figure 2: Evaluating Workflow – Users can evaluate the need for an AFP and analyze NAS constraints

Modeling

Once the need for an AFP has been established, NTMS must determine what the best course of action is to address the demand-capacity imbalance. To do this, NTMS will create a “Baseline Proposal” of an AFP, tinker with input parameters to create a “Revised Proposal”, then compare both proposals to determine which is preferred (Ross). To create this baseline proposal, users can draw an FEA/FCA line or select from existing FEAs/FCAs. After inputting model parameters including rate and altitudes, the NTMS will select “Add Proposed AFP” [Add Proposed AFP](#). Both delay metrics and an FSM graph are generated on the right monitor, and the corresponding data card, input parameters, and FEA/FCA line are shown on the left monitor. NTMS can view these outputs, as well as view EDCT assignments [View EDCTs](#) and add other TMIs [+](#). Now that the NTMS has created their baseline proposal, they can make slight revisions on the baseline to create the revised proposal. Once the user hits “Add Proposed AFP” [Add Proposed AFP](#), they will be able to compare the two data cards side-by-side to determine which proposal is the optimal solution, as shown in Figure 3. The left monitor will continue to reflect the selected data card on the right monitor, where the connection between the two monitors is emphasized with a blue border. Before implementing the proposed solution, collaboration with other facilities must happen to obtain feedback and determine if the solution is optimal for their needs. This is facilitated through the collaboration tool, where users can send a detailed summary of the model [d](#) to relevant facilities.

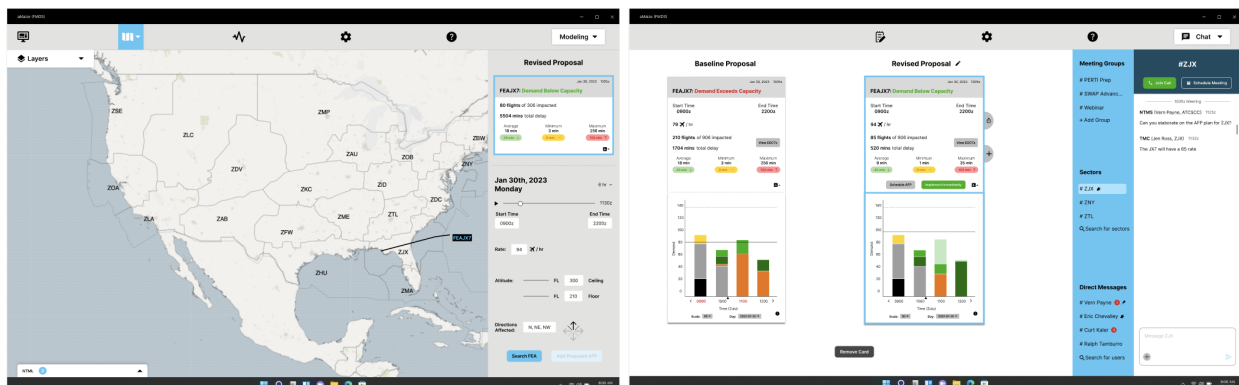


Figure 3: Modeling Workflow – Users can input AFP parameters and view metrics summarizing the proposed AFP’s impact (left). More details and a collaboration workspace are on a second monitor (right)

Once facilities and customers have approved the model, NTMSs can either implement the AFP immediately Implement Immediately, as shown in Figure 4, or schedule it for a later time Schedule AFP by providing a start and end time. Regardless of when the AFP is implemented, selecting either option will prompt the user to confirm the action via a pop-up. Details about the AFP are then automatically pushed to NTML, and a textbox is included if users want to provide more detail. When an AFP is implemented, a notification is displayed on the NTML icon to alert users of a change to the NAS.

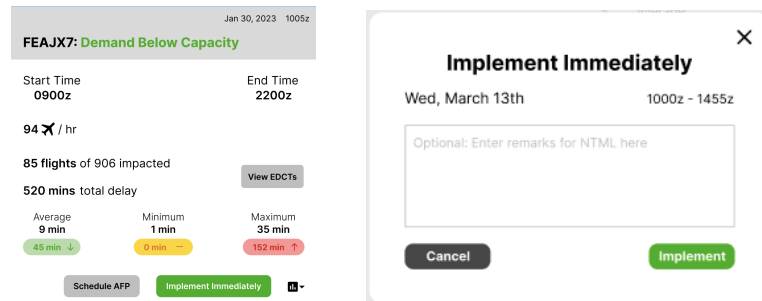


Figure 4: Data card summarizing proposed AFP's impact (left) and confirmation prompt when user immediately implements the AFP (right)

Monitoring

One takeaway from our user observations was that TFMS users often have five to eight FSM graphs open simultaneously, with certain presets that change depending on the region being monitored. From this, we designed aMaize to allow NTMSs to quickly generate up to eight FSM graphs of either active AFPs or evaluative FEAs Multi FSM Plot View, and display them in an orderly fashion to allow for efficient, concurrent monitoring. Since our PDR, we've added different viewing modes when more than one FSM graph is displayed:

- Default Mode: shows each FSM graph in equal size
- Theater Mode: spotlights one FSM graph, allowing the user to dive into one graph while still retaining other graphs on the screen for comparison
- Full-Screen Mode: maximizes one graph to fill the display, allowing the user to view up to 18-hours of flight data at once

Regardless of viewing mode, NTMSs can view FSM graphs in 5, 15, 30, or 60 minute intervals to better visualize the distribution of demand Scale: 60. Users can now toggle forwards > or backwards < in time to view up to three days of data. A "Day" drop-down menu Day: 2023-03-03 shows the user which date they're viewing data for. To help quickly view FSM graphs, users can create new presets Save As Preset if certain FEAs/FCAs are frequently viewed together or choose from existing presets. While "Monitoring", if the NTMS determines an AFP needs to be revised or purged, they can press the corresponding button. Hitting "Revise" Revise will return users to "Modeling", where revisions to AFP parameters such as flow rate or end times can be implemented. After implementing these revisions into the NAS, an update is automatically pushed to NTML. Users also have space to document the revision in more detail, such as why it occurred.

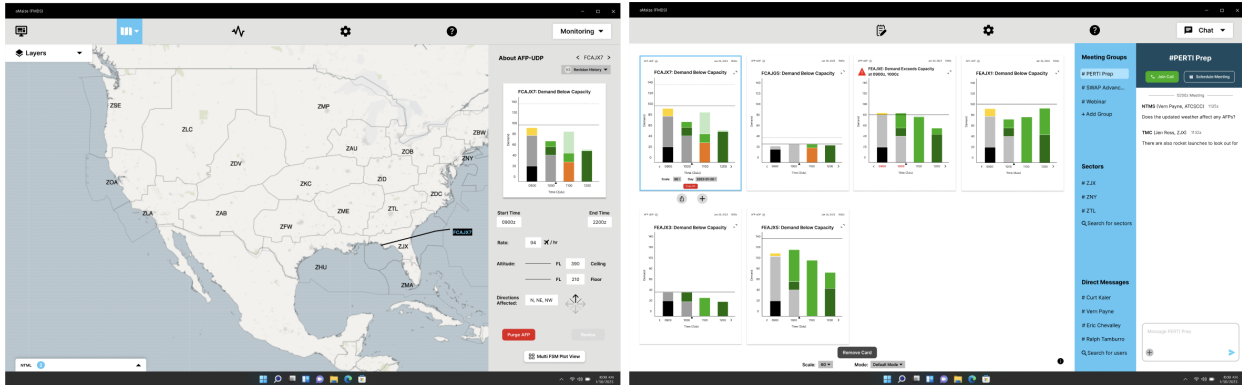


Figure 5: Monitoring Workflow – Users select an AFP to see its parameters and revision history (left) and monitor multiple FEAs/FCAs simultaneously (right). A blue outline indicates which graph is selected.

While “Monitoring”, if a NTMS determines that an AFP is no longer needed, they can select “Purge AFP” Purge AFP. This will prompt the user to confirm this action and include optional rationale for NTML, then purge the AFP from the NAS, as shown in Figure 6.

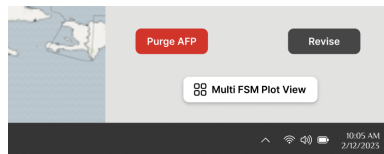



Figure 6: User can cancel (purge) or revise an AFP selected in the “Monitoring” screen

Once purged, aMaize will automatically push details of the purged program to NTML, and the user can include optional rationale in the provided textbox.

In addition to our three core functionalities, we developed a place users can reference to get a quick, high-level summary of everything happening in the NAS, called Dashboard, and an all-new collaboration tool.

Dashboard

When discussing the NTMS workflow, we learned from users like Curt Kaler, a TFMS Subject Matter Expert and Program Lead at Mosaic ATM, that NTMSs frequently start their shift by viewing the NAS Status Dashboard to orient themselves. We also learned NTMSs would benefit from having a centralized place to easily view weather updates and runway configurations. From these user insights, we developed a “Dashboard” View , shown in Figure 7. By selecting this view on the Global Navigation Bar, users can view info from the NAS Status Dashboard, a “Weather Forecast” map, hyperlinks to vital resources like the Ops Plan and Playbook, as well as weather tools used by NTMSs such as the Aviation Weather Center (AWC) Portal. The “Dashboard” View also helps users prepare for their day. On the right side, users have a schedule view, depicting their upcoming events and providing a place for users to block off time slots for other events. At the bottom of the schedule, users have the ability to input other users’ names to view their schedule to determine optimal meeting times.

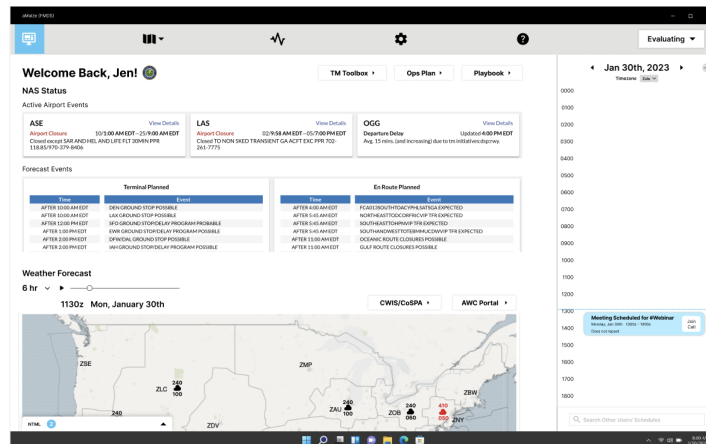


Figure 7: Dashboard View – Quickly see NAS-wide initiatives and aviation weather updates, and see upcoming meetings with a calendar tool

Collaboration

From our research, we learned that different parts of the NAS are strongly connected, and thus, CDM is vital to the successful management of air traffic. We also learned that users rely on various communication methods, primarily phone calls, to exchange information. To centralize the way users communicate, while adapting to their communication preferences, we've developed a new collaboration tool, which rests on the right side of the right monitor. By supporting both chat and voice communication, our tool caters to users who have traditionally preferred phone calls, while complementing it with the benefits of chat. This tool gives structure to users' conversations with threads. Each thread has an overarching topic: #ZJX shown in Figure 8, for example, is the communication thread for any issues or discussions related to the ZJX ARTCC. Based on the user's profile, aMaize automatically displays threads pertaining to the user's role, as well as any regions of interest. Alternatively, users can manually search for other threads. Users can also use the collaboration tool to send direct messages to other users. From our user research, we learned that knowing the user's role is more important than knowing their name. As a result, aMaize bolds the user's role in the chat thread, while including their name in parentheses (Figure 8).

Within each thread, users can chat and share data cards. Every thread has a voice room that mimics a Zoom call, with the added benefit that it is always active. Users can join at any time, and multiple users can be in the voice room at once. If a more structured meeting is preferred, members of the thread can schedule a meeting via the "Schedule Meeting" button under the thread header or via the "/schedule-meeting" hotkey. While scheduling a meeting, aMaize displays meeting times that work best for most members of the thread (based on users' calendars), while prioritizing the availability of key thread members. When users join the voice room, they can share their screen to show, for example, any data cards they've modeled or NAS constraints on the left monitor.

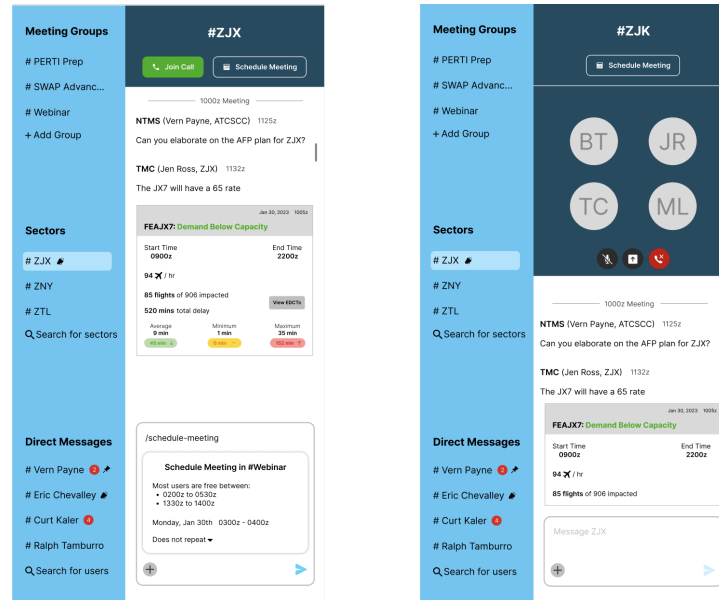


Figure 8: Collaboration Tool – Send messages, share data cards, schedule meetings, and join calls (left). Join voice rooms within a thread to collaborate and discuss strategy (right).

To limit noise coming from customers which may complicate early stages of the decision making process, we have decided to make the collaboration tool exclusive to FAA-personnel. Including customers may also create challenges in treating NAS customers equitably, because FAA colleagues may prioritize their response to certain customer chat messages.

Use Case: AFP for Jacksonville due to Convective Weather and Rocket Launch

During our research phase, we noticed that the main workflows a Traffic Manager progresses through when working with AFPs are evaluating the need for an AFP, modeling, and monitoring/revising. To accommodate this, we structured our product around these three core workflows. Let's illustrate these features through a use case. (Note: We recognize that there are many individuals in the Command Center who may not fall under the NTMS classification. For simplicity, we are referring to the end-user from start to finish in this use-case as NTMS)

It's January 30th, and the NTMS in the Command Center notices large thunderstorms impacting Florida and Georgia. To take a closer look, the NTMS launches aMaize, and opens up to the evaluating screen, shown in Figure 9. On the bottom right of the screen, the NTMS sees a chat message from Jacksonville Center expressing concern about the demand-capacity imbalance the weather constraint will cause.

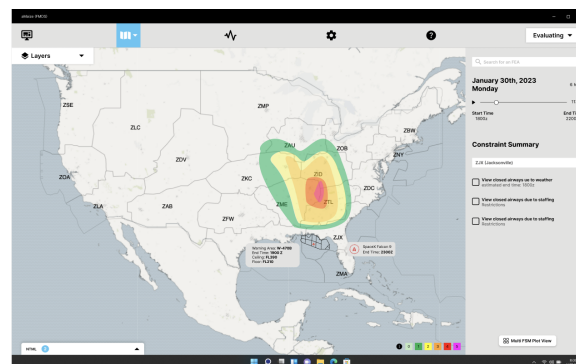




Figure 9: “Evaluating” screen launches where the user can analyze NAS constraints like weather.

Using the “Layers” tool , the NTMS enables weather so they can see the National Weather Service’s (NWS) convective weather forecast overlaid on the map. They also enable ARTCCs to see the boundaries of each ARTCC on the map, which helps the NTMS visualize centers that may be impacted by weather (Vassiliadis). While looking at the weather overlay, they look down at the bottom right of the map, where they see a color-coded legend, and hover over the pink box . This displays more explanation on the meaning of the color; pink, or category five, represents “widespread severe storms expected” (NWS). In addition to weather, the NTMS views another NAS constraint in Jacksonville: rocket launches. Due to the weather and rocket launch, the NTMS wants to get a better idea of the potential demand-capacity imbalance just south of Jacksonville, so they search for JX7, an existing FEA, using the search box at the top of the right pane shown in Figure 9.




After inputting parameters for JX7 such as altitudes to examine, the NTMS can see an FSM graph depicting capacity and demand by the hour, shown in Figure 10. They toggle forward  and backward  in time to get an idea of what demand is 12 hours from now.



Figure 10: FSM graph of FCAJX7 showing demand exceeds capacity. Times where demand exceeds capacity are in red for greater salience.

The NTMS can also change the timescale to 5 minutes, 15 minutes, or 30 minutes for a more granular view in case the hourly view conceals potential demand-capacity imbalances (Chevalley and Ross). The NTMS notices several features about the graph that make it easy to read. First, there are no grid lines that clutter the graph and make it difficult to interpret (Huckin and Olsen). Second, the colors in the legend have enough contrast that makes it easy to determine what each color represents in correlation to the graph. Colors that require attention are more salient, and flights that are less actionable have more subdued colors. For example, the NTMS cannot assign a delay to “Active” or “Arrived” flights, so these flights are dull gray and black. A black triangle  on the horizontal time-axis shows the current time. The solid black line indicates the new reduced capacity, whereas the lighter dashed line represents the unconstrained capacity. Times where demand exceeds capacity are shown in red to alert the user (new since PDR).

The NTMS decides to proceed with modeling an AFP and switches to “Modeling”, shown in Figure 11.

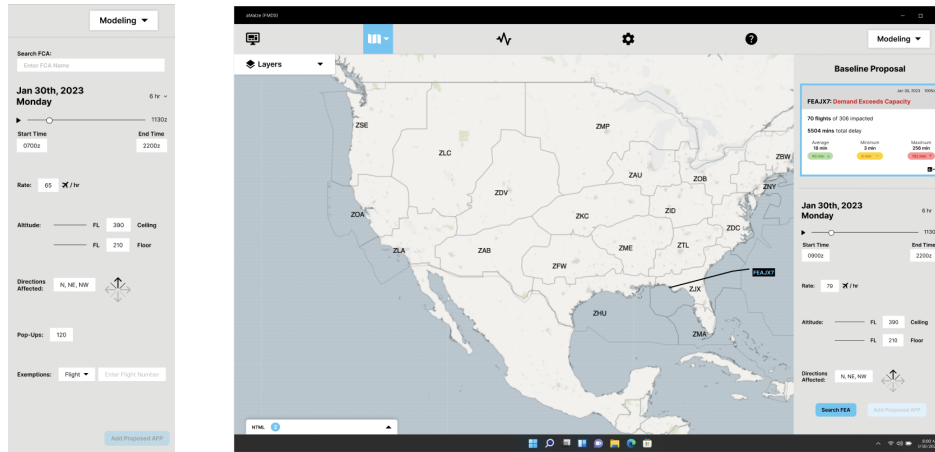


Figure 11: NTMS uses the “Modeling” screen to input parameters required to model an AFP (left). After an AFP is modeled, the user can see AFP parameters and impact summarized in a data card (right).

Here, the NTMS enters the required parameters for modeling an AFP, starting with selecting an FCA line. The NTMS can either choose from an existing FCA line or draw a new one. For this first - or baseline - AFP model, the NTMS types in “FCAJX7”, an existing FCA. Next, the NTMS inputs a rate of 79, and other model parameters, including start and end time, floor and ceiling altitude, and the expected number of pop-ups. The NTMS includes northbound flights, and verifies that other directions are excluded because only the northbound arrow is darkened. Although the NTMS can exempt certain flights, airports, airlines, and more, the NTMS chooses to make no exemptions for this model. To save the proposed AFP and view how it will impact the NAS, the NTMS clicks the “Add Proposed AFP” button. On the NTMS’ right monitor, a data card for the modeled JX7 AFP appears, as shown in Figure 12, summarizing the start and end time, the rates, and an impact summary of the AFP.

Recall that the baseline proposal had a 79 rate. The NTMS wants to experiment with a higher rate, changes the input rate to 94, and clicks the “Add Proposed AFP” button. This adds a revised proposal data card to the right monitor, and the user can now compare this data card with the baseline proposal. As more revisions are made to the revised proposal, its data card will update accordingly. In other words, there will only be a maximum of two data cards displayed at once. Not only does this limit the cognitive load on the end user, but it also aligns with how NTMSs model AFPs (Ross).

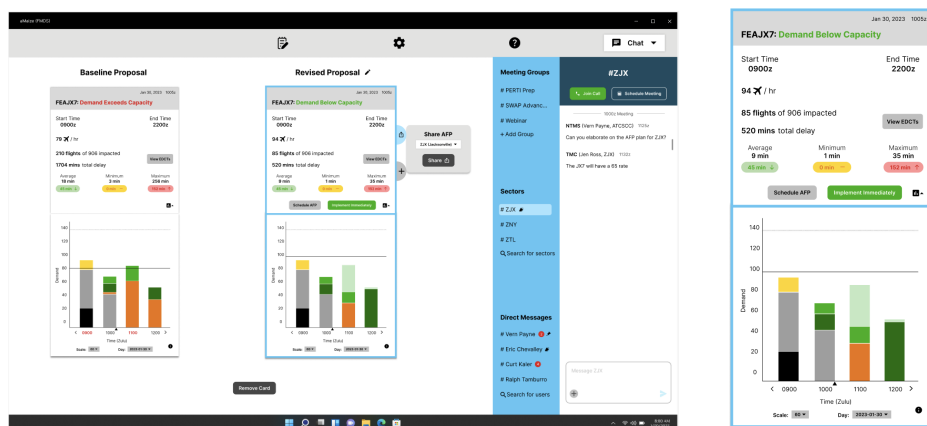







Figure 12: “Modeling” – NTMS’ right monitor is used to display the modeled AFPs, add other TMIs, and share AFP models via the Collaboration Tool. (Enlarged view of JX7 data card shown on the right)

On each data card, the NTMS can clearly see how many flights are impacted, the average delay, and the Expect Departure Clearance Time (EDCT) information . Pill-shaped colors below the average, minimum, and maximum delay metrics indicate comparisons of delay to no AFP. In the bottom right of a data card, the NTMS can view an FSM graph of the proposed AFP by clicking on the graph icon . Viewing the baseline proposal, the NTMS sees that the demand-capacity imbalance has still not been addressed. They can either add other initiatives via the “Add TMI” menu  to the right of the data card, or proceed with the revised proposal. Since this mockup is solely demonstrating the GUI for use with AFPs, more detail for creating other TMIs is not shown. The NTMS decides to proceed with the revised AFP proposal and shares it to the #ZJX thread via the “Share” icon . This inserts the data card into the #ZJX thread for Jacksonville Center and other FAA stakeholders to see, as shown in Figure 13. The NTMS decides to schedule a meeting to discuss the JX7 AFP model, types “/schedule-meeting” in the chat box and hits enter. A “Schedule Meeting” card displays in the chat box, and using the software’s suggested times, the NTMS schedules a meeting for 0300z and sends the invite to members of the #ZJX thread (Figure 13). At 0300z, members of #ZJX hit the “Join Call” button  to enter the voice room.

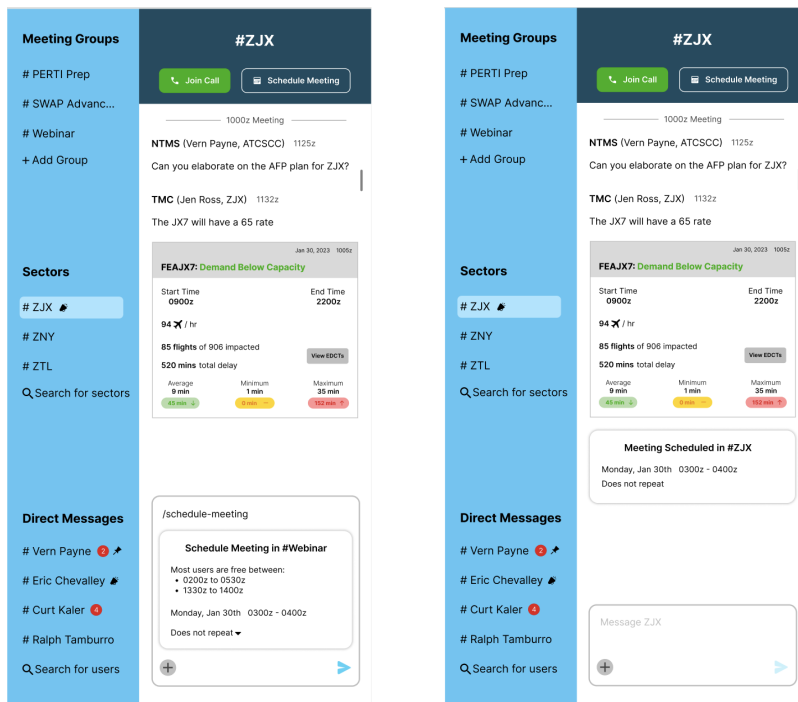



Figure 13: Collaboration Tool – Users can share data cards and schedule meetings to discuss AFP strategy within threads.

After conversations with Jacksonville Center and other stakeholders, the NTMS clicks the “Implement Immediately” button . A pop-up appears to confirm the AFP implementation, allowing the user to choose the end time (in Zulu). When the AFP is created, details about the AFP are automatically pushed to NTML, but an optional text box is included for more detailed rationale.

It has been multiple hours since the AFP was implemented, and the NTMS is now in “Monitoring.

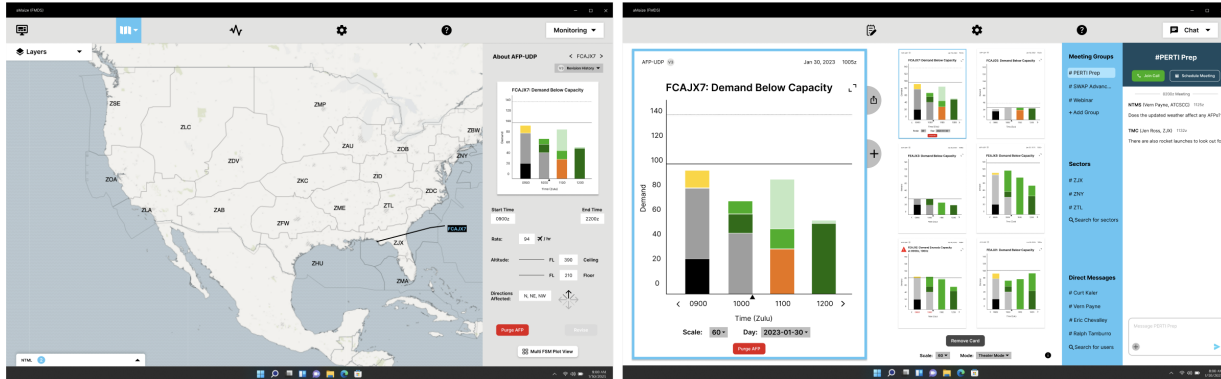


Figure 14: “Monitoring” – the NTMS views AFP details such as revision history (left), and can see demand-capacity imbalances of multiple FEAs/FCAs simultaneously (right)

In Figure 14, the NTMS has the active AFP selected (FCAJX7), as indicated by the blue outline around the FSM graph and how the selected FSM graph is shown on both monitors. Additionally, the user can find the current version number and AFP revision history, and other model parameters on the left monitor; JX7 FCA is also depicted on the TSD-style map. Clicking on a previous version under “Revision History” (top right of the left monitor in Figure 14) launches NTML, showing the log where the AFP revision was approved. On the right monitor, the NTMS has six FSM graphs displayed in “Theater Mode”: this mode enlarges one FSM graph (the active AFP in Figure 14) and shows the other graphs in a compact grid.

From the data card, NTMSs can cancel the AFP via the “Purge AFP” Purge AFP button. Revisions to the AFP can be made by editing model parameters on the left monitor.

Technical Risks

While the collaboration tool will have a tremendous impact on CDM, there are risks that come with this feature. Users can send sensitive language, spam other users, and engage in non work-related threads. Having said this, there are no privacy concerns with the collaboration tool, as messages and user profiles will be stored in the FAA’s secure servers, and not on a publicly accessible cloud network.

Since the PDR, we’ve taken steps to address the other technical risks. We’ve since clarified which aspects of our interface support customizable colors. Only notifications colors and objects on the TSD-style map are customizable. Colors on data cards are not customizable. Furthermore, a default color palette is included so that objects, such as plane color, are the same by default for all users. Lastly, we’ve designed user interactions for a segmented AFP strategy and that is covered in our CDR video.

Testing and Results

Through user interviews, we identified design flaws which led to user confusion and errors, and have since addressed these issues. We conducted several user tests and received detailed feedback for our interactive prototypes from former FAA personnel and airline operators. We provided users with 24” monitors, and tested readability on our own.

Our team met with a NASA human factors expert, data scientists, and developers of ATD-2, to have them assess our PDR Submission Review. From this meeting, we had the opportunity to assess our product in terms of common user pain points, as well as receive feedback regarding the human factors analysis of our overall design. Another emphasis of this meeting was to discuss the feasibility of a collaboration tool. One of the biggest takeaways from this was that minimizing notification fatigue is a necessity for users, and we have since incorporated ways for users to manage this. With our “Dashboard” View on the Global Navigation Bar, NASA provided us access to CoSPA to gain inspiration for our cloud-top icon, as well as other design choices pertaining to weather. Our overall interface was well-received, and NASA

emphasized how our interface streamlined collaboration and was intuitively structured around the three core workflows (Evaluating, Modeling, and Monitoring).

After finalizing our interactive prototype, our team performed user tests with Ralph Tamburro, former STMC in N90. Having over 20 years of experience, Ralph walked us through CDM within the FAA, and provided crucial insight regarding how restrictions are managed across facilities and how NTMSs collaborate. This influenced the design of our collaboration tool and user interactions for NTML. Ralph validated that our interface empowered NTMSs to easily evaluate, model, and monitor AFPs. He suggested including reminder notifications for upcoming meetings through the collaboration tool, and mentioned that an “undo” button ↶ in our “Drawing Tool” ✎ would be beneficial.

To understand the airline perspective, we conducted user tests with Jason Conolly and Bill Tuck from DAL’s OCC and ATM team, asking them to perform tasks from aMaize’s three core functionalities. Both found our interface easy to navigate, aided by familiar icons. Bill found that the “Theater Mode” for viewing FSM graphs replicates his current workflow - he manually sets up a similar view rather than auto-generating. Bill recommended one improvement: seeing 8-12 hours of data simultaneously rather than four. Due to time constraints, we were unable to make this change. However, to address this, we would shrink the width of each bar, which creates space for a total of 8-12 bars.

Wireframe and Mock-Up Illustrations

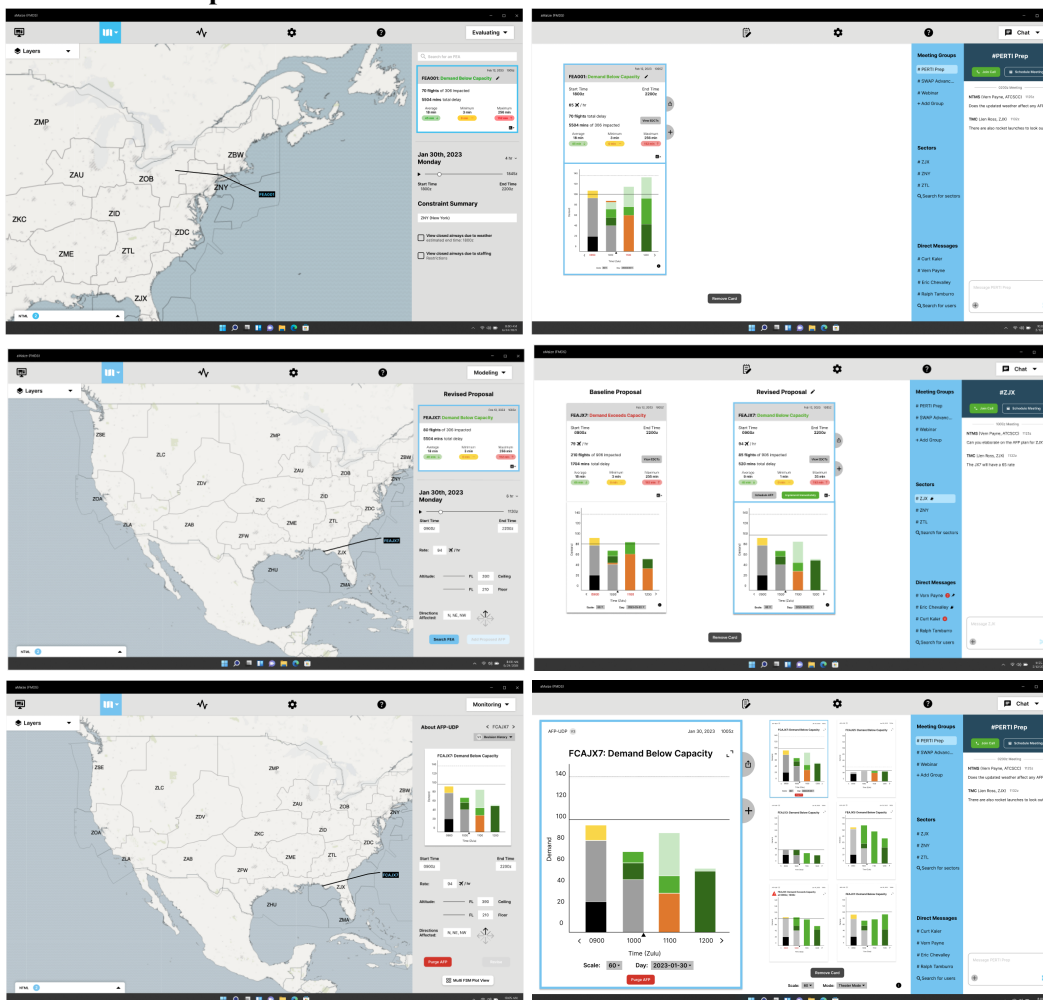


Figure 15: Final Mock-ups of Evaluating (top), Modeling (middle), and Monitoring (bottom)

PROJECT SCHEDULE

Our team has included a project timeline below, which covers the project's initiation in November, 2022 to the FAA TFM-AID Challenge Forum on June 27th to June 29th, 2023.

Phase	Tasks	Timeframe
Initiation	- Product Definition Document (Problem statement, scope, deliverables, early user research)	By Nov 30th, 2022
	- Complete AFP Research	By Dec 9th, 2022
	- Complete Expression of Interest	By Jan 31st, 2023
Detailed User Research	- Begin survey development	By Dec 12th, 2022
	- Meeting with Dr. Scott TenBrink (UX Research)	Dec 21st, 2022
	- Meeting with Erin Cobbett and Bill Tuck (DAL ATM)	Dec 23rd, 2022
	- Survey sendout and user interview invitations	By Jan 13th, 2023
	- Interview with Jen Ross (Jacksonville ARTCC)	Feb 3rd, 2023
Mockup Development and PDR Package	- Studied IDEO design-thinking textbook	Dec 9th-Jan 31st, 2023
	- Initial low-fidelity wireframe sketches	By Feb 4th, 2023
	- Weekly Review with Dr. Max Z. Li (Faculty Advisor)	Feb 4th-Mar 1st, 2023
	- First iteration of mockups	Feb 5th-14th, 2023
	- Second iteration of mockups	Feb 15th-23rd, 2023
	- Interview with NASA Human Factors and ATD-2 Developers	Feb 24th, 2023
	- Final iteration of mid-fidelity mockups	By Feb 26th, 2023
- PDR Essay + Video	By Mar 1st, 2023	
High-Fidelity Mockup	- Weekly Review / Update with Dr. Li (Faculty Advisor)	Mar 30th-June 7th, 2023
	- PDR submission review with Jen Ross	Apr 7th, 2023
	- Two iterations of high-fidelity mockups for collaboration features (collaboration tool, NTML)	7 days each, by Apr 13th, 2023
	- Meeting with Ralph Tamburro for N90 experience and discussion on CDM within the FAA	Apr 18th, 2023
	- Mockup for enhanced metrics, including distribution of demand and deviation from EDCT	Apr 22nd, 2023
	- Help menu and onboarding for new users	By Apr 30th, 2023
	- Meeting with Delta OCC and ATM regarding CDM	May 1st, 2023
	- PDR submission review with NASA Human Factors	May 4th, 2023
	- Mockup notifications to inform users of AFP changes	May 6th, 2023
	- Mockup interaction for Segmented AFP Strategy	May 8th, 2023
	- Meeting with Curt Kaler regarding collaboration	May 11th, 2023
	- Meeting with Curt Kaler regarding NTML	May 18th, 2023
	- Meeting with NASA Human Factors for design feedback	May 19th, 2023
	- User test with Ralph Tamburro	
- User test with Delta OCC and ATM	May 22nd, 2023	

	- User test with NASA Human Factors	June 6th, 2023 June 19th, 2023
CDR Package	- Final iteration of interactive prototype of GUI	June 2nd, 2023
	- 15-20 page technical paper	June 6th, 2023
	- Complete Demo/"How-To" video of GUI	June 6th, 2023
	- Presentation outline (pitch, GUI demo)	By June 10th, 2023
	- Slide deck for 25 minute presentation	By June 20th, 2023
	- Practice demo of GUI	By June 20th, 2023
	- Practice presentation	June 16th-June 27th, 2023

Since the PDR, we met with additional FAA stakeholders and airline operators. This, combined with the judges' feedback on our PDR, guided every design choice when iterating on our mockups. As a result, we developed a new collaboration tool, redesigned how NTML is structured, and worked to unify information displayed on both monitors. To standardize the look and feel of our interface, we created a final style guide and ensured that our minimum font size remained easily readable. We have updated our designs to abide by the ten usability heuristics of user interface design, enhancing the overall experience for users.

Our team made some modifications to our project plan since the PDR submission. When speaking with Delta, we learned that redesigning how customer EDCT assignments are displayed is a significant undertaking. As a result, we focused on developing other features more closely related to the scope of the TFM-AID Challenge, such as NTML and our Collaboration Tool. Additionally, although our team planned to create mockups for onboarding screens, we saw our CDR video and in-person demonstration at the TFM-AID Challenge Forum as an opportunity to demo our product functionality. As a result, we dedicated our efforts to improving our product's functionalities.

TEAM DESCRIPTION

Because we believe diversity is synonymous with great design, our team is comprised of students from three different colleges at the University of Michigan. As Team Lead, Sinan formed a multidisciplinary team of students from Michigan's School of Information and STAMPS School of Art and Design.

Sinan Abdulhak is a former Air Traffic Management (ATM) Co-Op with Delta Air Lines and a senior majoring in Industrial Engineering at the University of Michigan. At Delta, he's gained experience analyzing the utility and impact of TMI's like AFPs, participated in CDM initiatives like NSR and NCF, and created a digital product that the ATM team relies on daily to help understand the effect of TMIs given different NAS constraints. Sinan is passionate about human-centered design and has sought out experiences to build his design-thinking skills. In the fall of 2020, Sinan took a Digital Product Design class, where he created a digital product concept for Trip.it, a trip planning website. In addition to learning how to define product opportunities and project scope, he conducted user research, developed user personas to understand customer pain points and needs, and designed high-fidelity mockups in Figma and a working prototype with InVision. Trip.it is now featured on the University of Michigan's Center for Entrepreneurship website. Beyond designing digital products, Sinan draws on his experience as an Industrial Engineer to bridge the gap between data analysis and presentation. At Delta, he's leveraged UX design principles to present data in easy-to-interpret ways, and has developed frameworks for analyzing operational events that are now incorporated into his team's daily workflow.

Tyler Carvette, a recent graduate specializing in Information Analytics, is leveraging UX research methodologies to better understand the perspectives of TFMS users, uncover pain points with TFMS, and translate results into design choices. Having enrolled in courses such as "Needs Assessment and Usability Evaluation" and "UX Research in the Public Sector", Tyler has firsthand experience working with external clients to define their needs and implement UX research strategies to capture the needs of both the client and the end user. With projects lasting as short as four weeks, Tyler has competence in communicating professionally with a client while working in a fast-paced team context. Making use of his connections, Tyler reached out to UX Research Experts from the University of Michigan School of Information to validate research approaches before reaching out to FAA stakeholders.

Kate Shen, a recent graduate in Art and Design with a minor in User Experience Design, brings experience in translating UX Research insights into digital interfaces that are aesthetic, intuitive, and user-centered. She has grown up with an art background but has primarily focused on UX design for the past two years. She has experience working with multiple startups through her summer internship during Summer 2022 to help companies create web and mobile interfaces. She continues to develop her skills by currently working with a startup, collaborating with founders and software developers to create the most user-friendly websites and applications. In addition, she has also assisted them in problem solving and ideating in various topics and ideas. Her courses during her college career have also helped her learn about user testing and user interviews, which are both crucial in product design.

Dr. Max Z. Li, a professor of Aerospace Engineering and Industrial and Operations Engineering at the University of Michigan, brings vital technical expertise as our advisor for the competition. Dr. Li serves as Director and Principal Investigator of the Laboratory for Air Transportation, Infrastructure, and Connected Environments (LATTICE) at the University of Michigan, where he addresses research problems that contribute towards a safer, more efficient, more resilient, as well as user- and equity-oriented air transportation system.

Together, the team is well-prepared and excited to develop a user-friendly, cutting edge GUI for FAA personnel to use. We envision this GUI, in conjunction with FMDS, will be critical towards achieving the vision of an Information-Centric National Airspace System (NAS), and enable more efficient management of air traffic.

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APPENDIX B - Acknowledgements

We would like to extend our gratitude and appreciation to the following individuals, whose help made our PDR even better and made our journey so enjoyable:

1. *Dr. Max Li*, our advisor who guided us along the way and connected us with resources to learn about AFPs
2. *Erin Cobbett*, Manager of Air Traffic Management (ATM) at Delta Air Lines, for her airline and operational perspective, and assisting us in reaching out to FAA Traffic Managers
3. *Bill Tuck*, General Manager of ATM at Delta Air Lines, for his operational perspective and TFM training courses
4. *Jen Ross*, Former ATCSCC and current Traffic Manager at Jacksonville ARTCC, for the FAA's operational perspective in managing air traffic with AFPs and other TMIs
5. *Eric Chevalley*, NASA Human Factors, for evaluating our mockups and providing a UX and data analyst perspective in his feedback
6. *Dr. Jeremy Coupe*, NASA ATD-2 Analytics Lead and Digital Information Platform (DIP), for his feedback on our mockups and helping us understand the workflow of AFPs in conjunction with other TMIs
7. *Greg Juro*, NASA DIP, for his feedback on our mockups and helping us understand the workflow of AFPs in conjunction with other TMIs
8. *Dr. Scott TenBrink*, Assistant Director, Civic Engagement, and UX Research Professor at University of Michigan School of Information, for his invaluable feedback on our survey and advice on the iterative design methodology which inspired our rapid design cycle approach while mocking up our product
9. *Tony Vassiliadis*, Dispatcher and ATM at Delta Air Lines, for his operational perspective and Python code that mapped ARTCC lines using latitude and longitude coordinates, helping make our interactive map more aesthetic

APPENDIX C - Survey Link and Screenshots + User Test Link and Screenshots

Survey: https://docs.google.com/forms/d/1xFlpBRkr0PF01JKotByyiYJ9XcEoPuFeph_suL6BWEk/prefill

Workflow Survey for TFMS Users

The FAA TFM aMaze Challenge was set out to design a new, more efficient user interface (UI) that will replace TFMS.

We want to understand the workflow and pain points of TFMS users to design a brand-new GUI for FADS. By answering these questions you can help us design an interface that will make your work faster, easier, and more collaborative.

All emails are recorded, and will only be used to schedule an interview (if opted in) and send the raffle prize to the winner.

*** Required**

Email *

Cannot pre-fill email

Who is your employer? *

Delta Air Lines

FAA

What is your occupation? *

ATIS/SC Traffic Manager

Dispatcher

SDM/SSOM

Air Traffic Control Tower

ARTCC - Air Traffic Control Center

TRACON

Command Center Employee

Other:

Specific Questions for Delta Airline Employees

How many meetings do you have with FAA personnel on a daily basis? *

< 7

7 - 10

11 - 15

16 - 20

21+

What is your role in evaluating the need for an APP? *

I contribute to discussions on the advanced planning webinars

My input helps create PERTI plans

Other:

What other TMs are commonly used when working with APPs? *

GDPs

Ground Stops

Clapping/Tunneling Procedures

Playbooks

CTOP/TOS

Miles-in-Traffic/Minutes-in-Traffic

Other:

What FAA facilities/colleagues and NAS users do you collaborate with? *

Your answer

How do you reference the Ops Plan if needed? *

On my PC

On my tablet (e.g. iPad)

On my phone

I don't explicitly view the Ops plan, but I hear about it in meetings / from other colleagues

Other:

What weather metrics and visualizations do you refer to when working with TMS? *

Cloud Coverage

Visibility

Wind Speed

Temperature/Dew Point

Precipitation

Other:

Name the source of the above mentioned metrics and visualizations. *

NWS

Delta Weather

CoSPA

Other:

Specific Questions for FAA Employees

How many meetings do you have with airline personnel and other FAA colleagues/facilities on a daily basis? *

< 7

7 - 10

11 - 15

16 - 20

21+

What is your role in evaluating the need for an APP and how it will be implemented? *

Your answer

When creating an APP, what features contribute to you deciding whether you will create a new FCA or select a pre-existing one? *

Location of Weather

Projected Volume of Air Traffic

Technology Outages

Other:

What other TMs are commonly used when working with APPs? *

GDPs (Ground Delay Program)

GS (Ground Stops)

Clapping/Tunneling Procedures

Playbooks

CTOP/TOS

Miles-in-Traffic/Minutes-in-Traffic

Other:

User Opinions

For airline employees: If a question says "when creating APPs...", think about a feature that would enhance airline-FAA collaboration.

Rank the interface of the following TFMS features in terms of ease of use (1 = easiest to use, 5 = most complicated to use) *

	1	2	3	4	5
GDT (Ground Delay Tools)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
TSD	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
FSM	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
NTML	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
FSA	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Identify two features of the TFMS interface that are most challenging to work with. *

Your answer

What about TFMS has become "handoff"? Are there any features that if changed would dramatically interfere with the usability of the technology? *

Your answer

Describe where in your current workflow you have to enter the same data multiple times. *

Your answer

What TFMS applications do you transition between most often? *

GDT and FSM

TSD and GDT

TSD and FSM

Other:

How many monitors do you allocate to TFMS applications? *

One Monitor

Two Monitors

Three or More Monitors

What features would enhance collaboration (e.g. better note-taking capabilities)? *

Your answer

Interview Interest + Raffle Prize

We are looking to gain more in-depth perspectives from interviewees. If you select 'Yes' below, you will be entered into a raffle to win a \$50 Amazon Gift Card! Interviews are expected to take place throughout the month of January.

Can we interview you to better understand your survey responses and your personal experiences with TFMS? *

Yes

No

User Tests:

<https://docs.google.com/document/d/1yPSnem0kdDIOzofpx8bJU8fuAFB1ju5mFeH3kjTorXM/edit>

Script and instructions: This is a usability test for aMaze, a graphical user interface of the FAA's Flow Management Data and Services (FMDS). aMaze unifies the 20+ TFMS applications into one interface, allowing FAA employees to work more collaboratively and facilitating user onboarding. It is also designed to be more intuitive and highlight information relevant to the traffic manager.

First, I'd like to ask you: Have you used TFMS while employed by the FAA before, and if so how many years of experience do you have using these TFMS services/applications?

- TSD
- FSM
- NTML
- TDCOM

What FAA facilities have you worked in?

Age?

The purpose of this study is to evaluate the design of aMaze from a user's perspective, ensuring user functionalities are comprehensive and efficiently organized. It is also to identify any issues with the interface, which can include difficulty in locating navigation buttons or navigating to a menu on the interface that is not related to a given task.

Throughout the study I'd like to ask you to think aloud. I will be recording results in a document I've created. Do you have any questions before we get started?

Tasks

Evaluating

- Open the Map View on the Left Monitor
- Using the Left Monitor, search for the New York Constraint Summary
- Open the Layers Tool on the Left Monitor, and select weather, rocket launches, or military airbases. Minimize the Layers Tool once you are done
- Using the Map View, select on the Drawing Tool
- You now have the ability to draw a custom FEA line on the map. Draw a line on the map in NY, and select Done to move on to the next step
- Name your FEA line, and select the button you expect to take you to the next step (select once on the Right Monitor)
- Using the Right Monitor, show me how to view the FSM Graph corresponding to the data card you just created (select once on the Left Monitor)

- On the Left Monitor, you see a chat message appear. Click on the message to view the entire message (click on the Right Monitor once)
 - After viewing this message, you turn your attention to ZSL. Remove the current data card you have selected on the Right Monitor (click on the Left Monitor once)
 - Using the Left Monitor, search for the Jacksonville Constraint Summary
 - Open the Layers Tool on the Left Monitor, and select weather, rocket launches, or military airbases. Minimize the Layers Tool once you are done
- Given the thunderstorms, weather, and rocket launch overlaid on the map, you have concluded that an APP is necessary to mitigate the demand-capacity imbalance. How do I switch from Evaluating to Modeling to create a proposed APP?

Modeling

- Search for FEA 'EAXJX7' on the Left Monitor
- You have just inputted the parameters, please add this proposed APP (click once on the Right Monitor)
- Now that you have created your baseline proposal, you would like to change the rate. Please change the rate, then add this new proposed APP (click once on the Right Monitor)
- Looking at the Revised Proposal data card on your Right Monitor, please select the button to Add TMs to your proposal
- Now select the button to share this data card, and share it with the #ZJK thread
- In order to start collaborating, use the collaboration tool's chat feature to type the header "/schedule-meeting" (click once on the Right Monitor)
- This takes users to a faster method of scheduling a meeting. Please send this meeting in the #ZJK thread
- Users can create other hotkeys in Settings. Please open the Settings menu on the Right Monitor to view the hotkeys section
- From here, navigate to the Notifications section, then to the Map section, and finally to the User Profile section, then close out of Settings
- It is time to join the voice room for the meeting you scheduled. Join the #ZJK voice room
- Now that the call is complete, please leave the #ZJK voice room
- With all stakeholders on board with your proposal, implement the proposal immediately using the Right Monitor. Before proceeding, be sure to include your rationale (click once on the Left Monitor)

Monitoring

- Please enlarge the NTML menu on the Left Monitor

- Now that you can view the log, please expand the log you just created by implementing ECAJX7 to view more details
- Using the search bar, NTMS can filter through NTML for specific logs. Use the search bar to search for MIT, then search for specifically at the ZNY facility
- Now close the NTML menu. Since we are in Monitoring, please use the Multi FSM Plot View button to monitor multiple FEAs/FCAs graphs simultaneously
- Using the Add Feature, search for ECAJX5 and add it to the plots
- You now have the FEAs/FCAs you would like to monitor. View these plots (click once on the Right Monitor)
- To remind yourself of what colors represent on the FSM graphs, please open the legend on the Right Monitor. Once opened, please close the legend
- Please switch from Default Mode to Theater Mode
- Please full screen ECAJX7, the selected FSM Graph, then return back to Theater Mode

Global Navigation

- Using the Left Monitor, please view the status of the Data Links, then close the Data Links menu

This concludes the usability test. I'd like to ask you to not share any information about the study. Thank you so much for your time!

APPENDIX D - Iterative Design Process: Evolution of the “Evaluating” Screen

