Development of a Search And Rescue (SAR) for the people of the Alaskan Yukon-Kuskokwim (Y-K) Delta region

Elias R. Breeden '26 and Sean P. Gleason

Rhetoric Program, Hampden-Sydney College, Hampden-Sydney, VA 23943

Abstract

This summer, I participated in a research project focused on developing a centralized dashboard to assist search and rescue (SAR) teams in the Yukon-Kuskokwim (Y-K) Delta region of Alaska. The primary aim of the project was to create a functional, user-centered tool that integrates multiple data sources, including interactive maps, environmental data, and survey information, to support efficient decision-making and improve the safety and effectiveness of SAR operations. The dashboard was designed to consolidate critical information, allowing SAR teams to access real-time and historical data, visualize trends, and coordinate efforts in a region characterized by challenging terrain and limited accessibility. By streamlining data collection, visualization, and communication, the project sought to enhance the operational capabilities of SAR teams in this remote area, enabling them to protect and serve their communities.

Background

The Y-K Delta region presents unique challenges for search and rescue operations. The terrain is vast, often difficult to traverse, and largely accessible only via boat, all-terrain vehicle (ATV), or snow machine. These limitations, combined with the sparse population and unpredictable environmental conditions, make locating missing persons especially difficult (SOAR Project Narrative).

Prior to this project, SAR teams relied on paper-based surveys and dispersed data sources, which hindered both the speed and efficiency of search operations. There was a significant need for a more efficient and centralized system for planning and carrying out SAR operations. The dashboard was envisioned as a solution to consolidate these disparate data streams, digitize information collection, and provide an interactive interface for mapping and analyzing operational data.

Project Goals

The project was guided by the following goals:

–Develop a functional, interactive dashboard that integrates maps, data layers, and a digital Lost Person Behavior (LPB) survey to support SAR operations.

–Streamline data collection by replacing complex paper-based surveys with a simplified digital format that is accessible across multiple devices and platforms.

–Enable real-time visualization of submitted survey data and other operational information to improve situational awareness.

–Design a user-friendly interface tailored to the specific workflows and needs of SAR teams in the Y-K Delta.

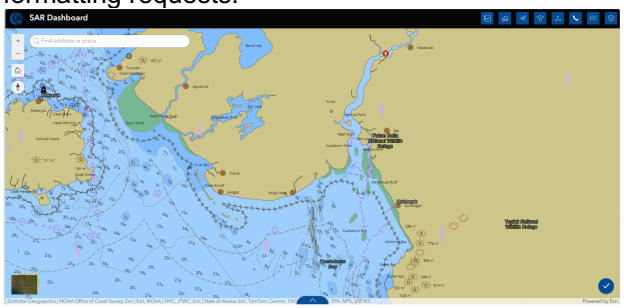
–Test and iterate the dashboard to ensure reliability, cross-platform compatibility, and operational utility.

Individual Role

My role in the project focused primarily on planning, organization, design, and front-end implementation. Key responsibilities included the following.

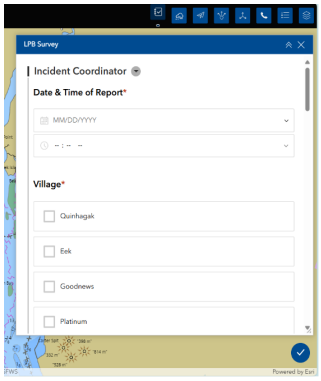
Design Planning and Prototyping.

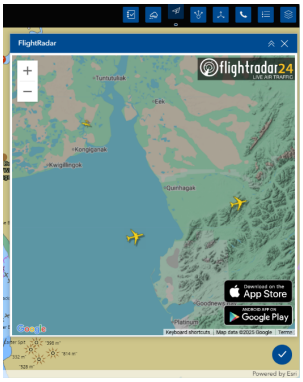
I developed wireframes, user flows, and visual design plans for the dashboard, ensuring that the interface was intuitive and aligned with SAR team needs. This process involved considering the most effective layout for maps, data layers, and embedded surveys without sacrificing functionality, as well as gathering feedback from stakeholders about specific formatting requests.



Development Support.

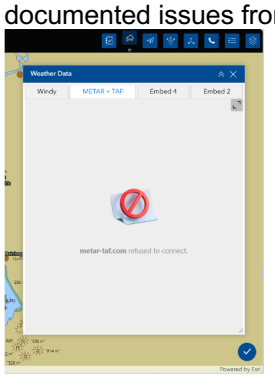
I worked collaboratively within a team, coordinating goals and utilizing code delivered by other members, to translate design plans into functional dashboard elements. While I did not develop the code from scratch, I contributed to configuration and implementation tasks, ensuring that submitted data could be stored, accessed, and visualized effectively. This included integrating survey submissions, setting up map layers, and coordinating functionality between front-end components and underlying code.





Beta Testing and Documentation.

I led the testing of the dashboard across multiple browsers (Chrome, Firefox, Microsoft Edge) and mobile devices, identifying issues related to data rendering, embedded content, and mobile functionality. I also documented testing outcomes and provided recommendations for future development, contributing to a structured plan for iterative improvement of the dashboard and its individual components. Furthermore, I worked to resolve documented issues from the beta testing phase.

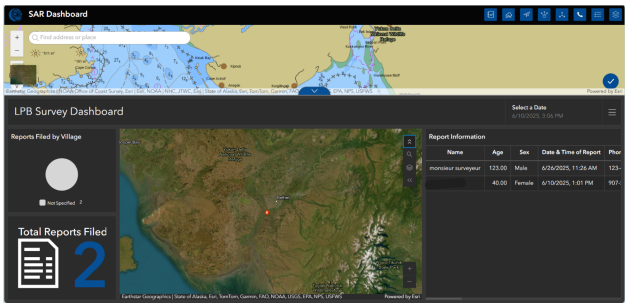


Accomplishments

Over the course of the project, I contributed to several key outcomes that demonstrate the functionality and accessibility of the dashboard as well as the effectiveness of the design process.

Functional Dashboard Prototype.

I helped create a working prototype that integrates interactive maps and layers, weather data, the Lost Person Behavior (LPB) survey dashboard (pictured below), and other pivotal data points. The prototype allows SAR teams to visualize submitted survey data alongside other critical information, providing a centralized view of operationally relevant data. Thus, streamlining the process and the time it takes to plan and enact a SAR operation. Notably, this prototype was deployed during an actual search and rescue operation, where it contributed to locating a missing individual.

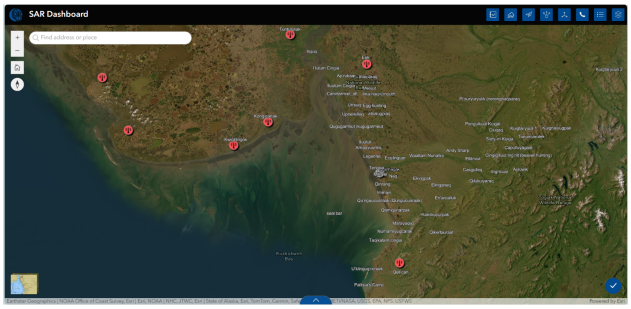


User-Centered Design Implementation.

Through careful planning and iteration, I ensured that the dashboard interface was intuitive, accessible, and aligned with SAR team needs and desires. This included designing clear yet effective navigation that is not overwhelming for users, layout consistency across the dashboard and its individual components, and effective visualization of complex data sets so that users are presented with the most important details. Overall, ensuring the dashboard was not only functional, but tailored towards the specific needs and desires of its end user, SAR Incident Command.

Map Layer Customization.

I designed and customized individual map layers within the dashboard (such as frequented trails, location names, cell tower locations, and pins for the last known location of missing individuals); allowing users to filter, update, and visualize data dynamically based on survey entries, individual reports, and other operational inputs. This allows the basemap to be altered to suit the needs of individual users and unique situations.



Digital LPD Survey Implementation.

Streamlined Data Collection: Responses are now submitted and integrated directly into the dashboard in real time, eliminating manual data entry for each individual survey submission.

Simplified Survey Design: The survey was reduced to its most essential elements, removing filler questions and unnecessary details, and enabling faster completion without losing critical information.

Dashboard Integration: Embedded in the bottom dock of the dashboard, the survey feeds directly into map layers and data visualizations that provide users with detailed information about missing individuals.

Enhanced Accessibility: Accessible across multiple browsers and devices, the survey supports SAR teams in varied field conditions and locations.

Automated Alert System: Upon successful completion of the LPB survey, an alert is sent to all necessary parties (i.e. incident command, SAR team members, etc.) signifying that there is a missing individual, noting information about the situation, and providing a link to the dashboard and the LPB survey entry.

Cross-Platform Usability.

The dashboard was tested on multiple browsers (Chrome, Firefox, Microsoft Edge) and mobile devices. These tests confirmed that the key map-based functionalities worked consistently, and that essential LPB survey data could be accessed effectively in many different locations and conditions.

Identification and Resolution of Issues.

During beta testing, issues such as incomplete data rendering in certain browsers, limitations in embedded weather data, and inadequacies with mobile formats were documented and addressed. These resolutions helped ensure that the dashboard functioned reliably across multiple platforms and devices.

Collaboration and Iteration.

I worked closely with team members to plan, design, and coordinate dashboard goals and individual objectives, as well as integrate code into the front-end design, refining features based on testing feedback and project goals.

Issues and Challenges

Throughout the development and testing of the SAR dashboard, several challenges emerged that shaped both the design process and the final prototype.

Data Integration Across Browsers and Devices.

Initial testing revealed inconsistencies in how different browsers rendered the dashboard and its embedded components. While Microsoft Edge consistently displayed all features correctly, Chrome and Firefox occasionally failed to render the LPB survey data and weather information.

Embedded Weather Data Limitations.

Integrating METAR and TAF weather information presented difficulties due to restrictions from external data providers. In some browsers, embedded weather content was blocked due to cross-site security settings.

Mobile Device Adaptation.

Presenting the dashboard on mobile devices required simplifying certain elements to ensure usability on smaller screens. Thus, reducing overall usability, but ensuring that essential functions remained.

Design Constraints and User Needs.

Balancing comprehensive data visualization with simplicity and usability required repeated design iteration, small tweaks to individual elements, and feedback from team members and stakeholders to ensure that dashboard elements aligned with project goals.

ArcGIS Online Affordances and Constraints.

The capabilities and limitations of ArcGIS Online influenced how individual dashboard elements could be developed and customized. Certain functionality required creative workarounds, while other aspects accelerated development.

Collaboration and Coordination.

Working with team-delivered code meant coordinating design requirements with existing functionality, which occasionally required creative solutions to align front-end design with available code. Additionally, this created occasional holdups in the front-end design of the project while issues were worked through on the back-end.

Despite these challenges, iterative testing, design adjustments, and collaboration resulted in a functional, user-focused prototype that demonstrated the dashboard's value in real-world SAR operations.

Recommendations and Future Work

Based on the outcomes of the project and the challenges encountered during development, several recommendations can guide future iterations of the SAR dashboard.

Expand Cross-Platform Testing.

While the current dashboard functions effectively across most browsers and devices, additional testing on Safari and other less common platforms will help ensure full accessibility and functionality for all users.

Enhance Mobile Functionality.

The mobile version of the dashboard currently displays only core map features and limited LPB survey functionality. Future work could focus on optimizing mobile layouts and integrating additional

widgets to provide field teams with more comprehensive access to critical data.

Refine ArcGIS Online Integration.

Continued exploration of ArcGIS Online capabilities could allow for more advanced data visualizations, interactive filters, and automated updates. Identifying platform limitations early in the development process will support more efficient design iterations.

Expand Data Sources.

Integrating additional operationally relevant data, such as real-time environmental sensors, or historical search data, could further improve situational awareness and decision-making for SAR teams.

Real-Time Tracking of SAR Team Members.

Implementing the ability to track individual team members on the map could significantly enhance operational efficiency and improve the safety of personnel in the field. While this addition would be technically challenging and require careful consideration of privacy and connectivity constraints, it represents a valuable potential enhancement for future iterations.

Live Video Feeds from Field Teams.

Incorporating live drone or GoPro feeds from team members on the ground could provide real-time visual information to improve situational awareness, guide decision-making, and enhance safety. Implementing this feature would require robust connectivity and careful planning to manage bandwidth and integration with the dashboard.

Iterate on User-Centered Design.

Gathering feedback from SAR team members who have used the dashboard in real-world operations will inform refinements to the interface, survey design, and data visualizations. Continuous user input will ensure the tool remains aligned with practical needs and operational workflows.

Develop Training and Documentation.

Providing clear guidance, tutorials, and documentation for SAR teams will support adoption, ensure effective use, and enable troubleshooting in field conditions.

Evaluate Impact and Metrics.

Future work could include formal evaluation of the dashboard's effectiveness during SAR operations, including metrics such as response time, data accuracy, and user satisfaction, to guide further improvements and justify continued development.

Skills Developed and Lessons Learned

Throughout the course of the project, I gained significant experience and developed a variety of skills that will be valuable for future research and professional work. Key areas of learning
Include the following.

User-Centered Design.

Planning and designing the dashboard required careful attention to the needs and workflows of SAR teams. I learned how to translate user requirements into functional interfaces and intuitive visualizations, balancing complexity with usability.

Collaborative Development.

Working with a team and integrating code provided by other members taught me how to effectively communicate design intentions, coordinate development tasks, and adapt to existing technical frameworks.

Data Visualization and Mapping.

Creating and customizing map layers, integrating real-time survey data, and designing interactive visualizations strengthened my understanding of geospatial data representation and how to make complex information actionable. This learning was supplemented by numerous courses from ESRI's training catalogue.

Program Proficiency.

I developed practical skills with ArcGIS Online and ArcGIS Pro, including tools such as Experience Builder, Dashboards, Map Viewer, and Survey123. Additionally, I gained experience with Microsoft Power Automate, using it to streamline workflows and automate data handling processes that supported the dashboard and survey integration.

Problem-Solving and Troubleshooting.

Beta testing across multiple browsers and devices exposed me to unexpected technical challenges. I learned how to systematically identify issues, test solutions, and implement design adjustments to improve reliability and functionality.

Project Planning and Documentation.

Maintaining records of design iterations, testing outcomes, and recommendations enhanced my skills in organized documentation, structured planning, and iterative project management.

Critical Thinking and Decision-Making.

Simplifying the LPB survey and determining which features to prioritize for the dashboard required evaluating trade-offs between completeness, usability, and efficiency, helping me strengthen my analytical and decision-making abilities.

Applied Research Experience.

Contributing to a tool that was deployed in an actual search and rescue operation provided hands-on experience in applying research and design principles to solve real-world problems with tangible impact. The structure of the project and the role my advisor played in the process also helped me gain an understanding of professional work environments and employer expectations.

Through these experiences, I developed a deeper understanding of designing user-focused digital tools, working effectively in a collaborative technical environment, and translating complex data into actionable insights, all of which are critical skills for both research and professional practice.

Reflections and Takeaways

One of the most rewarding aspects of this project was the opportunity to work directly with ArcGIS Online and its suite of applications. I especially enjoyed creating and refining the dashboard, and experimenting with tools such as Experience Builder, Dashboards, Map Viewer, and Survey123. The data visualization component of the work was what initially drew me to the project, and over the summer I was able to engage with it in an in-depth way. I particularly valued the process of being given a task and figuring out how best to accomplish it using the tools available to me. This iterative problem-solving approach strengthened both my technical skills and my professional development, and confirmed my interest in using GIS platforms for data visualization and mapping.

This project also helped me clarify my interests when it comes to the balance between front-end and back-end work. While I recognize the importance of back-end development and the value of having a baseline understanding of coding concepts, I discovered that my passions lie more in the front-end. I appreciated gaining the ability to talk about back-end processes at a surface level—such as APIs and webhooks—so that in the future I could communicate effectively with computer scientists in a collaborative setting. However, I learned that I am not particularly interested in pursuing back-end tasks like creating APIs myself.

There were also some aspects of the project that I found less engaging. Beta testing and troubleshooting browser compatibility, for example, often felt tedious even though I understood their necessity for ensuring a polished final product. I also occasionally found it frustrating to lack the technical skills needed for certain tasks, such as filtering the LPB survey data to display only the most recent entries on the map, which required more coding knowledge than I currently have. Similarly, limitations within ArcGIS sometimes restricted the dashboard's functionality in ways that constrained my vision for the project, occasionally making a seemingly simple task unachievable.

Overall, though, I greatly enjoyed and valued the work I was able to complete this summer. With the exception of some of the more tedious or back-end-oriented tasks, I found the project to be engaging, rewarding, and affirming of my interests in data visualization, mapping, and the front-end development side of GIS tools.

Conclusion

The development of the SAR dashboard for the Y-K Delta region represents a significant step toward improving operational efficiency, situational awareness, and safety for search and rescue teams. Throughout the project, I contributed to the planning, design, and implementation of a user-focused dashboard that integrates interactive maps, customized data layers, and a digital Lost Person Behavior (LPB) survey.

Key accomplishments include the creation of a functional prototype that was deployed during a real search and rescue operation, the implementation of streamlined and accessible digital surveys, and the development of interactive map features that allow for dynamic visualization and filtering of operational data. These contributions highlight both the practical utility of the dashboard and the effectiveness of a collaborative, user-centered design process.

Challenges encountered during development—including cross-browser compatibility, embedded data limitations, mobile adaptation, and platform constraints—provided opportunities for problem-solving and iterative improvement. These experiences informed recommendations for future work, such as expanding mobile functionality, integrating additional data sources, exploring real-time tracking and video feeds, and refining ArcGIS and automation tools to further enhance dashboard capabilities.

Through this project, I gained valuable experience with various programs, user-centered design, data visualization, collaboration, and applied research. I was also able to gain a better understanding of my own likes and dislikes pertaining to this field of work, while contributing to a tool with tangible real-world impact. The dashboard demonstrates the potential for technology to support complex, high-stakes operations in remote regions of

the world and provides a foundation for ongoing development, ensuring that SAR teams have access to the tools and information they need to operate safely and effectively in challenging environments.

Sources Consulted

ChatGPT

Quinhagak Search & Rescue, Inc. - https://nalaquq.com/quinhagak-search-rescue-inc/

SOAR Project Narrative