EXPLORING USER LOCALIZATION AS A DESIGN OPPORTUNITY THROUGH HUMAN-CENTERED DESIGN PRINCIPLES FOR THE NATIONAL HURRICANE CENTER HOME PAGE (NHC.NOAA.GOV)

by

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ABSTRACT

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Hurricane season in the United States occurs annually between the months of June and November and even though these months are set, there is still no telling how many hurricanes would appear and the severity of the impact, such as infrastructural damages and possibly human deaths. As such, when meteorologists illuminate the hurricane forecast, communicating that level of risk becomes important for evacuation and safety. However, The National Hurricane Center (NHC), the number one most visited site for hurricanes is not accessible. Looking at their home page, their structure lacks the appropriate design that would make their home information digestible for those critical users. The objective of this thesis is to examine how methods in human-centered design could aid in restructuring the current home page of the NHC, in order to effectively communicate the degree of hurricane risk with the ultimate goal of diminishing confusing user experience on the NHC home page. Since the target audience of the NHC primarily caters to people who are in hurricane-prone areas, the first half of the data collection consisted of user interviews with hurricane survivors and witnesses, with a specific focus towards Hurricane Sandy. We reviewed the data, and discovered opportunities and salient user personas. Out of the several opportunities, we picked one, which is designing for user localization, and from there, further user tests were conducted to survey the design's effectiveness of hurricane risk communication specified to the user's location.

We explored the opportunity to design the NHC home page for user localization, and we substantiated our findings through human-centered design methods. The first part of this process is identifying the people who would use the product. We coded quotes from the collected user interviews that highlight information seeking patterns and behaviors. Within that bucket of data, we tagged phrases or comments that are related to localization. The next phase consisted of developing user personas from those set of codes. The persona consisted of six sections relevant to user localization. In the first iteration, a total of ten personas were

created, and after two more iterations, some personas were combined, and others were put to the side, totaling into a final of four user personas. Concurrently, a competitor analysis was conducted to survey applications that implement user localization on their home page. Over fifty applications were analyzed. Based on the findings from the user personas and competitor analysis, we started prototyping and iterating on the design that caters to user localization. User participants were then recruited to test the design, and roleplay one user persona for testing. All feedback from participants confirmed that the user persona reflects the design for user localization.

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1 Introduction

The National Hurricane Center website (https://www.nhc.noaa.gov/) under the National Oceanic and Atmospheric Administration receives heavy web traffic from hurricane-prone areas as well as non-vulnerable regions that are candidates for an incoming hurricane in the United States. The information structure of the current National Hurricane Center website does not wholly encompass the amount of data that is displayed, which may decrease the usability of the interface, and in turn, could confuse users and lead them to initiate actions that deviate from the original product goal. With the National Hurricane Center website, risk communication is a high priority goal for users who desire information that would enable them to take action before, during, or after a hurricane.

Disasters, including hurricanes, are socially constructed events that lean on observing human behaviors from a systematic scale. In the modern era, more information exists in digital formats. Effectively communicating weather data through a user interface would require a deeper dive into an individual user, specifically his or her immediate needs and behavior in the course of a disaster. Hurricane Sandy occurred within the decade, where information consumption has already proliferated on the web. As part of a more giant conglomerate studying hurricane risk communication, the first half of the research is data collection, specifically focusing on Hurricane Sandy through qualitative user interviews, mainly presented through oral narratives, observing various types of information exchange and the decisions that ensued after that.

There was a consistent pattern of information seeking behaviors that depended on technology. Mediums such as television, mobile devices, computers and laptops, and even radios are mentioned as a source of news for weather updates in vulnerable and non-vulnerable hurricane areas. Each medium also had different types of interaction [1] . A mobile device was used to call or text family and friends to either retrieve more information or share information based on their location. Along with calling and texting, the mobile device as well as computers and laptops were used as a platform to check on social media and a variation of news outlets. One similarity between all of them is that the user centered their information seeking behavior towards their location, such as typing in a location to check for news, or asking someone if they know what is happening around their neighborhood.

1.1 Human-Centered Design Approach

The main component for our design methodology relies on human-centered design principles [2]. We wanted to further understand why user localization is an important feature to include for applications that communicate hurricane risk communication. In order to investigate this opportunity, we started with initial discoveries based on literature reviews and collected user interviews, then we synthesized the information into bucketed themes. During this process, we developed user personas and journey maps. After the data was synthesized, we started designing low fidelity prototypes. This session included sketching and brainstorming design ideas and conducting competitor analysis. The final part consisted of designing the final prototyping, testing the product, and iterating the prototype design.

2 Related Work

2.1 Channels of Communication

When communicating hurricane risk communication, there are many channels available to distill the data. However, depending on a given situation, each method of communication would be more beneficial than other forms. Accordingly, each medium is tasked with reaching the broadest range of the population. Picking out which type of communication to use may not be as important. According to a NOAA study, those who are seeking information should be generally aware that danger is present and their lives might be at stake, and having multiple ways of receiving warning information would help with making better decisions [3].

Television and radio stations are grouped together by NOAA. They routinely broadcast authorized "warnings" and "watches" sourced from the National Weather Service. Their on-air meteorologists also divulge the latest forecasts and storm tracks that are developing. The advantage of a television over a radio is that the visual display allows for communicating graphics and radar displays, that would be helpful for an individual who is visually impaired, or finds visual displays easier to digest and follow as opposed to listening to an audio [3]. The downside to both mediums is that they are dependent on electricity, and radios and televisions are often fixed to a certain location. A radio in the car would not be accessible if someone leaves the vehicle, or a television would not be viewable from another room.

Another prevalent channel of communication are mobile devices. Emergency alerts such as a recent kidnapping or incoming environmental disasters would often induce the device to ring. Depending on the maker, Android phones are integrated with Google and they have weather alerts that would turn the device into a siren for a few seconds, alerting the user about the danger that may be near their area. However, this may not be suitable for those who are driving, since an alert may be distracting, and could potentially lead to a car accident if the user decides to focus instead on the blaring notification instead of the road [3].

In order to improve the channels of communication, partnerships that contribute to the Hurricane Warning System should also be strengthened. All share the common goal of saving lives and preventing further environmental damage and harm. Guaranteeing a smooth transfer of information between three groups, as well as providing each other flexibility could improve the clarity of the weather news for the public [4].

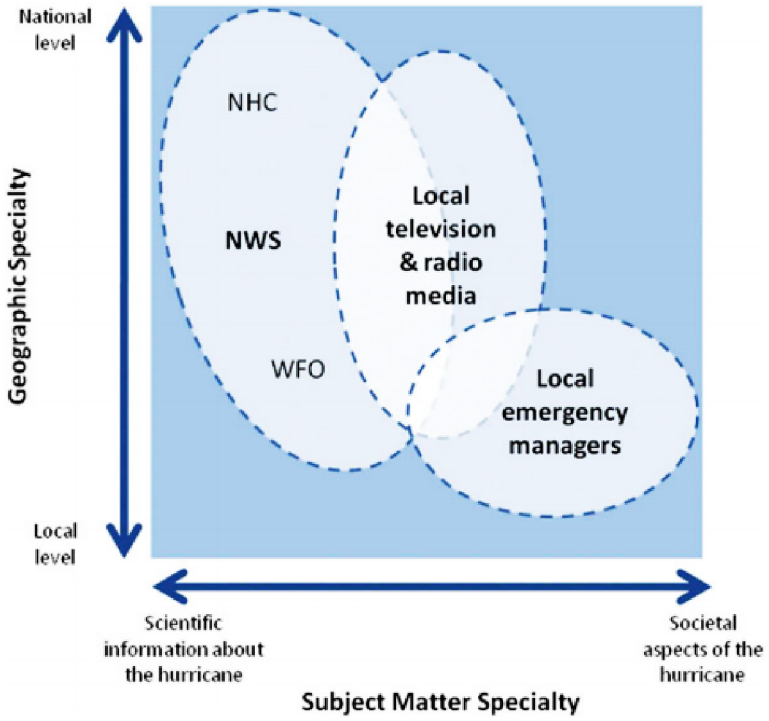

Figure 2.1: Geographic and subject matter specialities of the groups in the hurricane warning system by Demuth

2.2 Risk Perception and Decision Making

Given the weather information, the user would analyze how much risk is within their environment, and in turn, affect their decision making based on their perception of danger. Risk perception and decision making are affected by several factors, such as evacuation orders and past experiences with hurricanes, as well as obstacles that may be of sociocultural or economic origins [5].

2.2.1 Evacuation Orders and Past Experiences with Hurricanes

When an evacuation order is seen by an individual, there is a sense of alarm that the individual perceives, shaping their decision making in the process. Past experience with a hurricane that turned into a near miss for the subject may lead to ignoring future evacuation orders. However, there is more evidence that prior experience with hurricanes increases the chances of evacuation, since that individual may already have a plan in place [5].

Those in vulnerable areas like coastal areas of South Carolina have established a community that has a support for environmental disaster awareness and preparedness. Residents in that area who completed a minimum of three actions to prepare for a hurricane were over 200% more likely to evacuate than those who did not prepare [6]. Citizens who were also highly concerned about the hurricane, were more likely to evacuate, and there is a margin of people who choose not to evacuate if they have experienced hurricanes throughout their lifetime.

2.2.2 Obstacles Affecting Decision Making

Urgent evacuation orders may not be enough to overcome obstacles and other considerations that would impede evacuation. In *Modeling Hurricane Evacuation Decisions with Ethnographic Methods*, Hugh Gladwin mentioned four variables that affect the decision to evacuate [7]. The first would be age, then proximity to a vulnerable area, perception of risk towards the hurricane, and intra-household bargaining factors, such as protecting financial assets.

These intra-household bargaining factors could be broken down further within the context of race and culture. As shown from the aftermath of Hurricane Katrina, a substantial chunk of American communities exist without the appropriate social and economic support "necessary to protect themselves and their families during disasters." Many did not evacuate because they lived in poor residential areas that prevented them from establishing preparations for hurricanes [8]. Also, these communities live in areas with less infrastructural support. Other concerns such as "ethnic insensitivity, racial isolation and racial bias" are possible factors that lead to "lower levels of preparedness, fewer resources for evacuations, and disparities in access to relief and recovery."

2.3 Visual Display of Hurricane Risk Communication

2.3.1 Design Suggestions

NOAA released a final report on improving hurricane forecast. In their summary, "Hurricane Forecast Improvement Program Socio-Economic Research and Recommendations: Final Report" they suggested a few insights for how the public may interpret the storm surge maps. People are inclined to check for landmarks to find their homes on maps. Legends tend to be ignored. The concept of "feet above ground level" is not understood. The color blue implies water or a body of water. People are used to color as a reference for checking the level of risk. Purple is more likely to receive attention than the color red [9]. The phrase "very low" could be

interpreted as having little to worry about, and generally most requested an indication for the water depth in feet.

In a 2019 study by Bica, the main conclusion stands that graphics do better than statistical representation for communicating risk. People sharing photographs and visual images closer to the disaster perceive the situation with a different level of quality and accuracy, as opposed to those who are checking the disaster from afar [10]. Moreover, tweets that show evacuation graphics, usually maps have the most interaction, and replied to for a longer duration of time as opposed to other risk images. In another one of their studies, they discovered that the general public would often request for information local to their particular location, which could be areas that they would pass while travelling, their homes, or locations of their friends and families. As such, they have added that risk information visualizations should follow a design pattern that provides the user agency to contextualize the risk communicated to their own situation, as opposed to applying this to a broader audience, such as an entire state.

2.3.2 Designing for Communicating Uncertainty

Hurricane risk communication primarily revolves around distributing information to increase certainty about an approaching hurricane. However, that type of information is not completely solid, hence that comes with a level of uncertainty. Forecasters and emergency managers often assess the level of uncertainty when they announce warnings [11]. Communicating uncertainty may mean emphasizing certain data, like a range of time rather than a fixed stamp for measuring the estimated time for a hurricane hitting land. Providing a level of uncertainty could make people make better decisions because this gives them more autonomy to decide whether they should take a risk or not. Hence, the display of visual maps that track every single movement of the hurricane may not be as viable rather than a static image of a map. The important part for designing how to communicate for uncertainty is identifying the users and finding their “particular tasks they’re trying to do with the given data at that particular moment” [12].

3 User Interviews

3.1 Conducting User Interviews

Oral narratives center the interview on the individual, which wholly considers behaviors and reactions that form the personal experience. They are a means of collecting stories that give color and contextualize an event that may be generalized by public observation [13]. Oral narrative encourages the voice of the interviewee, rather than trying to actively seek out answers that would apply to the research questions. The interviewee mostly leads the direction and pace of the interview

A sample set of user questions are referenced as a guide. Standard demographics and background questions are asked at the start of the interview to serve as a soft opening for the interviewee. These set of starter questions consist of inquiries on current residency, professional experience related to disasters, and special needs for emergency preparedness. As the interview progresses, the interviewee would eventually impart a larger narrative. At any given point when the interviewee may feel like he or she is struggling to recollect an event or articulate a detail, then another set of questions regarding past experiences with disasters are provided. Some interviewees may also want more leading questions than others [14].

3.2 Generating Codes

The interview sessions are roughly 30 to 45 minutes long. All participants agreed to recording, and each recording is transcribed via Otter, a web application that converts audio to text. The file is then downloaded as a raw text, and pasted on a Google Document. The first reading pass includes grammar correction that the converter did not catch, as well as a general familiarization of the oral narrative. The following reading passes applies the method of coding based on grounded theory.

These oral narratives on Hurricane Sandy each supply partial evidence. Human behaviors and emotions are not necessarily quantifiable, but they do have forms that could be studied and approached by observing repeated patterns of ideas, concepts, or language elements. On the Google Document, if a theme emerges, the section is highlighted, and a code is attached as a document comment. Compelling points that may not fit into a theme are also marked as sidenotes, and points of interest that could be later examined. Transcriptions are tagged with

codes, until most of the themes have been exhausted. Codes are constantly rehashed and evaluated, and then they are consolidated into memos [15].

3.3 Overview of Patterns and Codes

We used four buckets to categorize the codes and patterns: actions and decisions, information seeking and sources, prior experience, and how they were impacted. We discovered from the total of 35 user interviews that have experienced various hurricanes across the United States, including 1 user interview from Puerto Rico. Across all interviews, codes relevant to information seeking and sources were grouped together. The design opportunity for user localization is extracted from this section. For example, the following subsections are codes from Hurricane Sandy. They reveal patterns of location-based information seeking behaviors that reinforces the opportunity for user localization.

3.2.1 Hurricane Sandy Code: Deciding to Evacuate in Vulnerable Areas

Interviewees that did not have enough knowledge on hurricanes were more likely to express a lack of concern before the onset of Hurricane Sandy. Those who did express concern were either academically piqued about weathers or lived-in vulnerable areas. Hurricane Sandy affected the Mid-Atlantic region of the United States, including North Carolina, Virginia, Maryland, Delaware, New Jersey, and New York. The participants that were interviewed were either in New Jersey or New York during Sandy.

Lily (Pseudonym):

> Okay, um, well, I live in East Rockaway. That's where my house is. And we had evacuated the night. Like, I guess it happened like that Sunday, Monday, Sunday into Monday and we evacuated Sunday night so we weren't home or in the neighborhood when the storm actually hit.

Also noted, Lily had recently moved to her coastline residency two months prior to Hurricane Sandy. She did not belong to hurricane community groups, and felt that her inexperience with storms caused her to evacuate just hours before the impact.

3.2.2 Hurricane Sandy Code: Gathering Real-Time Information about the Weather

Those who did not have enough information on the hurricane were more inclined to retrieve information based on their immediate surroundings. They explored the neighboring area, checking for clues that reflected the state of the storm through visual cues, such as fallen trees, sand on the road, demolished structures, or store closings. Social media was also used to passively gather information that was concurrently happening outside.

Elly (Pseudonym):

> I remember I used to know the reason why the power went out. I've forgotten now. But there is something that they did not account for. And you saw all the lights go out neighborhood by neighborhood. Like I looked out the window, and thought "Wow."

4 Finding Opportunities

As mentioned before, this thesis focuses on user localization as an opportunity, and belongs to a larger collective effort that consolidated and presented 18 design opportunities to the NHC group. Those opportunities were synthesized from 67 literature reviews, 35 interviews with hurricane survivors and witnesses, and a heuristic evaluation of the NHC website. These 18 design opportunities are grouped into four sections: Making NHC information more relatable and accessible to the public, NHC's role within the risk information ecosystem, further insights into critical questions, best practices in user experience and web-design, and the last group, alternative design methods. After presenting the list, the NHC group expressed an interest in designing for user localization.

4.1 Picking User Localization as a Design Opportunity

The main purpose for displaying hurricane risk information is to serve the public users, ensuring that they make appropriate and responsible decisions as a response to an incoming environmental disaster [4].

Hurricane risk communication is a precarious subject to approach because the information that would be shared would be distributed to the public, and once that information is received, however much people saw that information, would then make a decision based on that data. Hence the primary goal of hurricane risk communication is to make sure that the product being delivered should promote appropriate and responsible decisions for the public users, that would help in saving their lives, avoiding injury, and also protecting their property and other financial investments that would potentially be damaged [16].

Communicating at a level where an information is too generalized could feel a little bit distant. The user may not feel connected to the product because there is no indication that this information is catering to their needs. As such, taking advantage of this opportunity to design for user localization would help in somewhat contextualizing the situational awareness of the user. Providing localized information would also provide the user more autonomy, giving them a framework that is accessible within their bounded environment [17]. The difference between showing a map of a hurricane rotating in the Atlantic Ocean would feel less relevant, as opposed to a map that shows how far away the hurricane rotating in the Atlantic Ocean is from the location of the given user, or the estimated landfall that is closest to the given input

location. At the moment, the National Hurricane Center does not support localization overall, and the parts where they do, is often discrete and buried, where the design still excludes the needs of an individual user.

5 Human-Centered Design for "Localization" Opportunity

The main premise of the human-centered-design follows the general concept of the diamond model, an approach to decision making that brings together divergent thinking and convergent thinking throughout the ideation and prototyping process [18]. During the divergent phase, we gathered as much information as possible about why user localization would be necessary to adapt for the NHC homepage. The convergent phase is merging these insights and opportunities together, or removing some of them. The emergent phase is examining the insights derived from the divergent phase, and after examining, they could either go back to a divergent phase where new insights could be added to the collection, or go to the convergent phase, where this insight could be removed, combined, or merged with another insight. We adapted the diamond model into a human-centered-design approach, where a section could either be convergent or divergent [18].

5.1 Developing User Personas

The crux of the user personas referenced for this design opportunity is based from the Hurricane Sandy interviews, which consisted of 12 participants. The codes that were picked focused on their behavior towards their immediate surroundings, and how they were retrieving information before, during, or after their experience with a hurricane. Comments that indicated that the user was seeking information relevant to their location were noted as a code for user localization. From these collected codes, quotes were filtered and a sample persona is created from the participant that was interviewed. The draft persona is not fictitious. For the first iteration, the sections selected for the persona consisted of their demographics, source of information, hurricane they have experienced, general behavior towards how they have gathered information, and the last part is a quote that provides more detail for their behavior.

Current Demographics
Gender: Female
Age: 20-25
Occupation: Student

Referenced Weather Sources
Online - New York Times
National television

Social media: Facebook
Local municipality - Rockaway, New York, NY
Information from family members and friends

Hurricane Information
Name: Sandy
Year: 2012
Category: 3
In vulnerable area: Yes
Near vulnerable area: No

General Weather Information Retrieval
Lida received her news through national television. She did not specify any channels, but she mentioned that most of the weather news she was receiving are from large media outlets. Her main source of information is through her friends and family, as well as scouring the internet, comparing different articles. She has a difficult time trusting news.

User Journey
Flight was delayed due to a false warning about a storm
Arrived back in New York a few weeks before Hurricane Sandy
Community ignored Hurricane Sandy due to the false alarm
Water levels rose all the way up to the second floor of certain buildings
People drowned and cars were floating down the street
Her house became a shelter for her friends and neighbors

Quote
"So people were posting things on Facebook, they were posting like Emmons avenue of like how high the water went up. And like, they were posting pictures of restaurants that literally got flooded, like the owners of the restaurants and that was going really viral because it was, it was posted as things were happening. And I feel like social media was where people went to, just to hear what other people are talking about, you know, as opposed to like a news outlet. That's kind of I guess, like, yeah, I think social media was like, a more utilized virtual space than like, the news, at least for us."

Figure 5.1: Hurricane Sandy participant persona draft

Formalizing the results of the user interviews into a format similar to traditional user persona provides a reference and a foundation for drafting the content for the final draft of personas. User personas are critical because they provide an outline for software testers to follow, and

scenarios to execute once they are faced with the product. With this in mind, the primary design goal is to develop for user localization, and thus the sections included on Figure 5.1 references if the area is situated in a vulnerable location, as well as noting actions that are related to their position at the time.

A few sections were updated from Figure 5.1 The local municipality was included in the referenced weather sources which implies the participant's location, but the demographics did not include the location. As a result, the draft persona (Figure 5.1) does not explicitly state the location of the participant. Hence, for the finalized user personas, the demographics include: gender, age, occupation, and location. Other variables for the demographics such as family status, education level, race, or income were not included because these variables were not considered during the user interviews. The most that was asked was in terms of educational level if the participant had any familiarity with emergency management or hurricane risk communication.

Figure 5.2 below shows the result of 1 of the 4 personas. As mentioned, the demographics are now updated with the location. Another important part of the persona is the hurricane information. The hurricane name is fictitious but the parameters are based off of Hurricane Sandy. The next section shows the persona's status, in this instance, Chloe's thoughts and emotions towards news sources. From the user interviews, several participants remarked their relationship with information shared through the internet and news outlets, and their personal biases affected their decision making. As an extra tidbit, the persona also includes a section for political affiliations. Similar to Figure 5.1, their sources for weather information is listed on their persona.

User Persona
Chloe

Demographics
Gender: Female
Age: 24
Occupation: Marketing Analyst
Location: Hackensack, New Jersey

Hurricane Information
Name: Laura
Year: 2020

Category: 3
In a vulnerable area: No
Near a vulnerable area: Yes

Attitude towards information retrieval
Active in various social media platforms and has a hard time trusting any type of news.

Political leaning
Slightly left-leaning

Sources for weather
Reddit
Instagram stories
Facebook live feed
Texting and calling family and friends

Goal
Desires to know if her near environment would be safe for her to stay.

Background Information
You're a 26-year-old bartender that recently moved to Hackensack, New Jersey. You formerly lived in Harlem, NY. You have not experienced a hurricane but have experienced heavy rainstorms. You don't know anyone in Hackensack and most of your Harlem friends are sharing news about the incoming hurricane via text. One of them suggested that there may be flooding and surges in places within the general tri-state area of New York, New Jersey, and Connecticut. You go to Google and type "hurricane info" and the first result that comes up is The National Hurricane Center. You click the link and arrive at the home page, expecting to learn more about hurricanes and if this incoming hurricane could flood your neighborhood.

Figure 5.2: 1 of 4 of the finalized user personas

Assuring that the objective is clear, the goal is incorporated right before the background information, which is the sum of text that would be roleplayed by user testers. The last section would be the most informative and accessible part of the user persona because the background details of how this person may decide to navigate the NHC home page. The demographics are not enough, even with the other segments, such as the goal because they do not have enough context to individualize, and simulate a scenario where user localization could take place [19]. Hence, a storytelling background would enable the tester to relate to the character more.

5.2 Conducting Competitor Analysis

The NHC is not the sole source for timely presenting hurricane risk information. Companies like Google, and other weather-focused applications also prioritize any incoming disaster alerts. A central component that confirms the reliability of their product is user localization. Provided that the user has access to a wireless network, their location is picked up right away by the application, and successively, they are shown data relevant to their location. Conducting a competitor analysis provides a range of design ideas for applying user localization to the NHC home page. This would help in identifying the product's unique value proposition, and differentiating what NHC offers from the competitors' services.

Google Search displays the forecast when the query "weather" is entered, as well as alerts directly on the search interface. Clicking on the weather card will show additional information. This is limited but the little snippets immediately provide information. The NHC could use to provide snippets to churn out quick data regarding important alerts. They also have ad specific location which is great for local businesses.

Figure 5.3: Google Search weather interface

NYC Hurricane focuses on evacuation orders, and is very local to the user. The side also lists evacuation sites that are available based on the location of the user. NHC could have a separate page from evacuation sites that pull in data from a specific location, or it could show a list of websites like this based on the user's location.

Figure 5.4: NYC Hurricane weather interface

A competitor analysis also stresses what actions are worth observing from the competitor, especially if a component is done right [20]. Through these audits, relevant industry patterns also emerge, which helps with ensuring that the design would be viable as an up-to-date product. Knowing where the competitor falls short also opens up opportunities to test ideas. However, this is not much of a problem for the NHC home page because they have all the data support to experiment with new concepts for reporting risk, but their informational display could be improved.

5.3 Creating the Design

With keeping the user personas and competitor audits in mind, the first part of the design process is referencing the current NHC home page, and the current function of user localization. Through the usability heuristics referenced from the Nielsen Norman Group, the NHC home page was investigated in order to scope the clarity of the information, and the efficiency of the user localization used for retrieving maps and other data related to hurricane risk information. The other half of the design process consisted on iterating upon low-fidelity and high-fidelity prototypes made on Figma. Altogether, the design was influenced by the accumulated data collected through the practice of human-centered-design principles.

5.3.1 Usability Heuristics of the NHC

Observing the existing user interface on the NHC home page provides substantial guidance for what kind of data is available, and which areas the design would need to emphasize for integrating user localization. Conducting these heuristics also provided insight for which areas are less relevant for designing a localized experience [21].

Visibility of the system's status: users should be given feedback on what is happening within a reasonable timescale. A timestamp is provided which shows that the webpage has been updated, and the bold red font declares a "Gale Warning." The system status is visible but the information being displayed regarding the content of the status is ambiguous, and may not necessarily be important to a given user.

Figure 5.5: Checking for visibility of system status on the NHC home page

Match between system and the real world: information should be presented in a means familiar to the user including language and conventions rather than terms developed for the system. Information should be presented in a logical order. The map does represent a real-world graphical example which consists of the weather forecast, but the underlying problem is the focus of the map. People are more familiar with their local geography and the map defaults to a larger scale that may not necessarily be recognizable to users who do not observe maps.

Figure 5.5: Checking for match between system and the real world on the NHC home page

User control and freedom: users make mistakes. There should be an "emergency exit" which is easy to find and exit the current system state without having to jump through hoops. Undo and redo functions are essential. This is a web page which is hosted through a browser that has its own set of navigation and toolbar, so a user could close the window if they choose to do so. The webpage relies too much on the browser's capability rather than creating a user experience flow that would give the user more freedom. The user has to press "back" in order to reset the state of the map if links like "Maine Forecasts" were clicked and so forth.

Figure 5.7: Checking for user control and freedom on the NHC home page

Consistency and standards: words, actions, situations, etc. should always mean the same thing and users should be able to understand that. This area uses phrases like "experimental" which is ambiguous, and there are also acronyms that are thrown around that denotes the source but could be confusing for users who are not familiar with these government organizations.

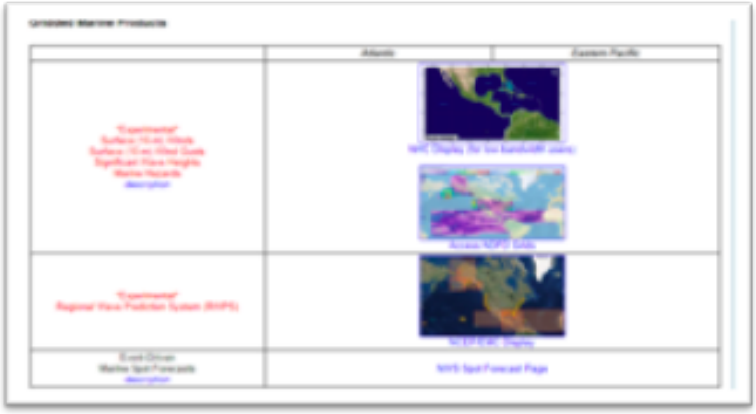

Figure 5.8: Checking for consistency and standards on the NHC home page

Error and prevention: preventing errors is better than clear error messages. Eliminate error conditions or make users aware that they may be about to occur and ask them if they want to proceed. The purpose of the user is to determine information about a hurricane relative to his or her location. They are more likely to click random links on a page where there is no direction. The map key legends are also buried inside a PDF, which would be helpful if this were placed next to the map instead.

Figure 5.9: Checking for error and prevention on the NHC home page

Recognition rather than recall: reduce the load on a user's memory. Make actions, options, and objects visible. Users shouldn't have to remember things from one screen to the next. Instructions should be easy to access when needed. The map is recognizable as a source of information for weather forecasts, and there are also blue buttons that indicate that these texts are clickable and would lead to a different page. There are familiar actions integrated into the page, but the actions have no substance or root that refers back to the user's original goal.

Figure 5.10: Checking for recognition rather than recall on the NHC home page

Flexibility and efficiency of use: the use of accelerators, where appropriate, may be invisible to new users but improve the efficiency of use for experienced users. Actions could be customized by users. Accelerators are often coupled with interaction, and this webpage has little interactivity. There are no shortcuts to certain actions. Mostly all components are static (images and links), and some information that would benefit an accelerator are deep linked.

Figure 5.11: Checking for flexibility and efficiency of use on the NHC home page

Aesthetic and minimalist design: dialogue should not give irrelevant or rarely useful information. The more data in dialogue the more it diminishes the overall visibility of individual points for the user. This area is heavy with jargon, and too much data that becomes over encumbering at first glance. The information presented is complex and not simplified, and the interface lacks the skeletal structure to compress all of that information into a readable chunk.

Figure 5.12: Checking for aesthetic and minimalist design on the NHC home page

Helps users recognize, diagnose, and recover from errors: this means error messages should be in clear language and avoid the use of codes. They should explain the problem and offer a solution to that problem. There are no error messages that would indicate the user that he or she is violating the flow, but from the red text indicated on the home page, if there is an error, maybe the color reference would be similar to the figure below.

Figure 5.13: Checking for user recognition, diagnosis, and recovery from errors on the NHC home page

Help and documentation: the best approach is to construct a system which needs no help or documentation but if it is necessary – it should be easy to search, be based on the tasks the user wishes to execute, offer concrete steps to follow and be kept to a minimum. The webpage is teeming with downloadable PDF files that explain these maps, and sometimes the files themselves lack structure and also need clarity. A user could feel lost and undecided as to which file would be useful for a specific task.

Figure 5.14: Checking for help and documentation on the NHC home page

5.3.2 Sketching Low-Fidelity User Personas

To start off the sketches, each user persona received a customized home page based on their profile needs. Creating sketches for all the personas brought to light which design components overlapped, as well as the sections that were too personalized. The goal of the low-fidelity sketches is to find areas of common ground between the user personas because the NHC home page should be able to address the needs of all the completed personas, which tallied to a total of four. Figure 5.15 below is the low-fidelity prototype associated with the user persona referenced above, Chloe.

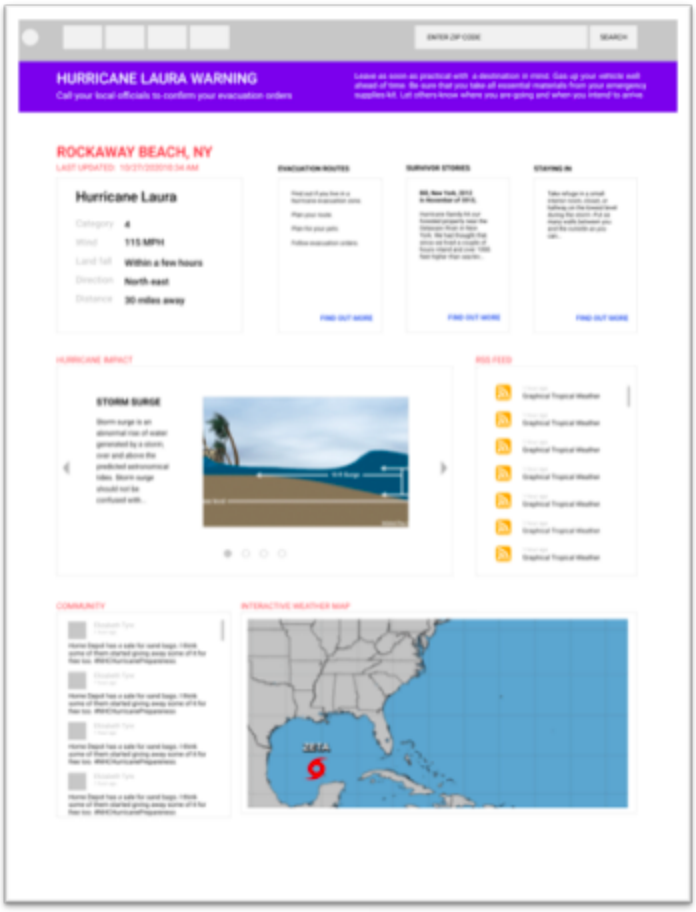

Figure 5.15: Low-fidelity sketch of Chloe's user persona

Figure 5.15 presents a sketch is based on Chloe's full profile (Figure 5.2). The sketch integrates four factors that are pertinent to the character, such as hurricane awareness, political leaning, evacuation safety, and connection to social media, which are all contextualized based on the user's location. All the way at the top, a navigation bar exists with an input text box for entering a zip code. Below the navigation is a banner containing an evacuation warning. On arrival at the home page, the user would also notice that the information defaults to their location. This section shows the status of the incoming hurricane. Moreover, an interactive map is included at the bottom of the page, and a carousel section shows scientific diagrams of hurricane-related phenomenon. While, the rest of the sections are oriented towards social media, which is a medium of preference as stated on the persona. This sketch serves to include all those variables but did not fully consider the information hierarchy because that is reserved for the synthesizing the overlapping components across all sketches.

5.3.3 High-Fidelity Design

After synthesizing all sketches from each user persona, two components were retained based on intersecting needs: hurricane awareness, as well as evacuation and hurricane safety. These two sections are organized further into smaller components across the page. Hurricane awareness consists of an input query for entering the zip code. This would give the user autonomy to search weather alerts in areas of concern that could be places such as destinations or homes of friends and family members.

Figure 5.16: High-fidelity design for zip code input

Figure 5.17 is emphasized out of all the other components. This portion immediately shows that user localization is taking place because the zip code, along with the town and state associated with the user's IP address. Afterwards, a timestamp indicates when the home page was last updated, as well as the estimated time of arrival for the incoming hurricane. All are directed towards the present location of the user. The last section shows the category of the incoming hurricane and what kind of damage and danger could be expected.

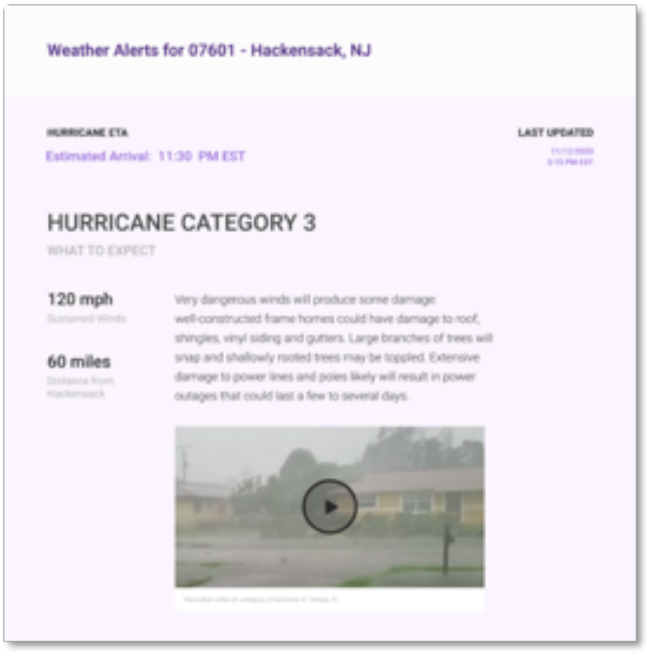

Figure 5.17: High-fidelity design warning message component

The last component for hurricane awareness is the map. There are three sections available for the map: cone of uncertainty, surge flood, wind speed, and cyclone probability (which is hidden on the preview). The carousel shows three previews at a time, and highlights and displays the centered map. All user personas have indicated a concern about the effects of an incoming hurricane within their physical surrounding. A map instantly refers back to their location, and visualizes the location of the hurricane relevant to the area of interest. The two important maps consist of the cone of uncertainty and surge floods. The cone of uncertainty shows areas that could be disturbed. Some maybe in near-vulnerable areas may not need to evacuate. While surge floods present the level of water in feet that in each respective color-coded figure. Wind speed and cyclone probability are extra data that the NHC has but not as salient to safety as the other two.

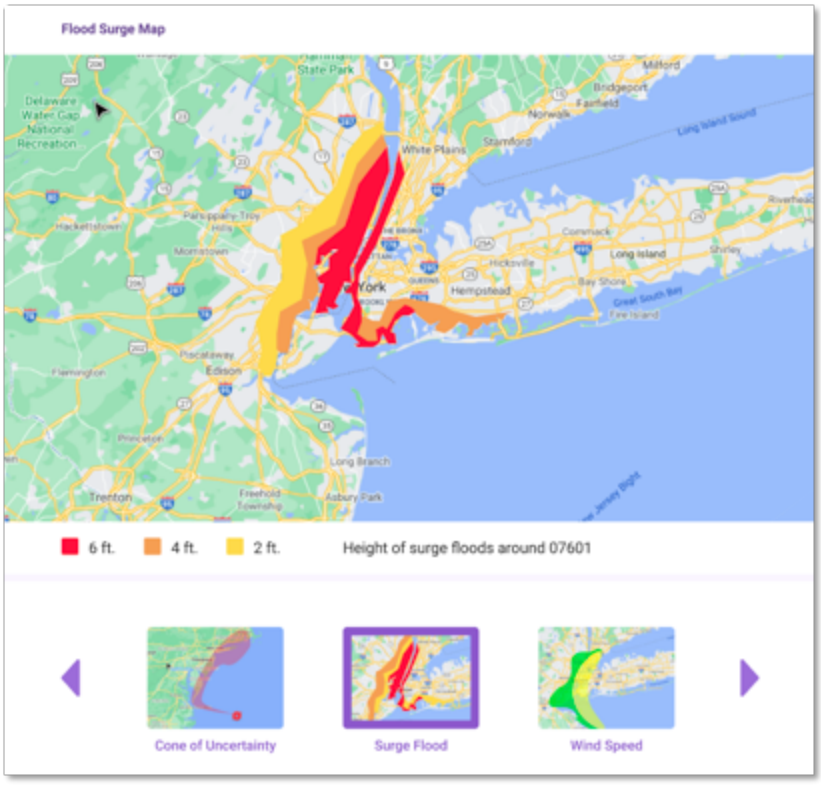

Figure 5.18: High-fidelity design surge flood map

The segment for evacuation is straightforward. Figure 5.19 below exists as the first part of the home page. A warning in yellow contains more information about where to receive evacuation orders. Users could choose to click the notice, and would lead them FEMA, where more questions regarding emergency management could be answered. However, the NHC website also contains general information about hurricane preparedness but understandably not as extensive as the FEMA website. The second part, Figure 5.20 elaborates on hurricane safety, which contains four sections: plan for evacuation, assemble supplies, check insurance, and strengthen home, which are topics that could be useful for all personas depending on the given situation.

Figure 5.19: High-fidelity design evacuation banner

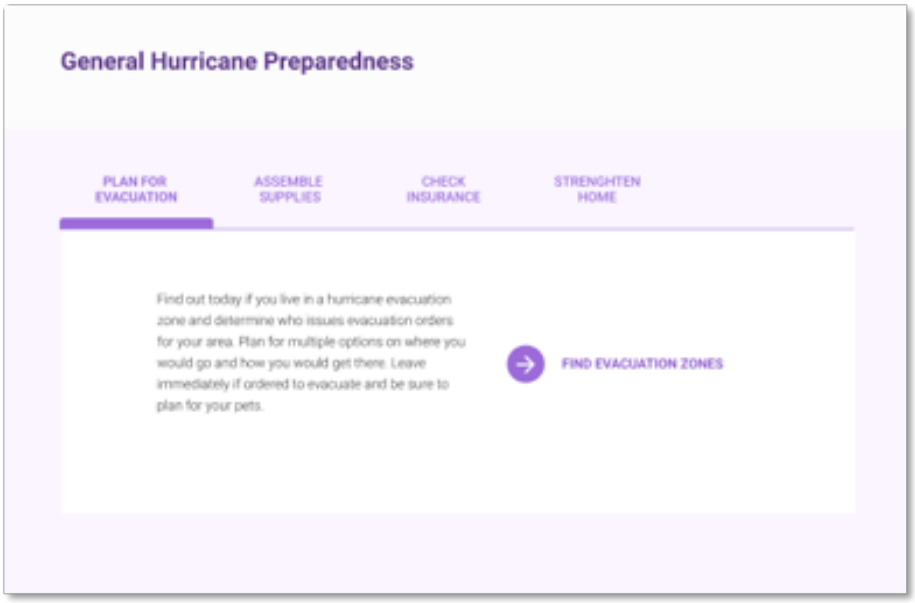

Figure 5.20: High-fidelity design hurricane preparedness component

5.4 User Testing

The last step is testing completed design as well as a persona. A total of five testers from an age group that was similar to Chloe, the persona they roleplayed. First, the tester is disclosed that they would be looking at a design exploration for the NHC home page. The subject of user localization was not disclosed to them because that may have affected their decision-making process while following the user persona. Each test lasted for about thirty minutes. On separate occasions, all of them immediately pointed out that the category of the hurricane was not clear. Figure 5.21 shows the prior iteration of the high-fidelity prototype. The information on the right is disconnected from the left because that section does not have any heading that would summarize the paragraph. All of them also commented that they assumed the video is a live-feed, and there is no sub label on Figure 5.21 that describes the content of the video.

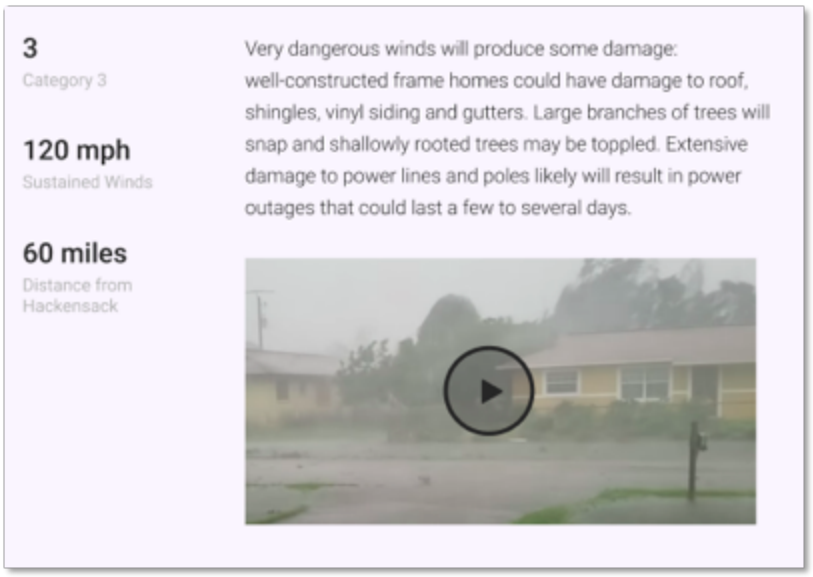

Figure 5.21: Before fixing the information hierarchy on the warning message component

A video label along with the changes to the information hierarchy are both applied to the high-fidelity prototype. The updated version is Figure 5.17. Overall, all users found the persona (Chloe) approachable and relatable, and all of them were able to determine the needs of Chloe based on her given location. The rest of the comments were personal opinions that did not apply to the persona but rather what they would prefer to see on the NHC home page.

6 Discussion: Generalizable Design Principles about Localization

There are three propositions that contributed to the successful user tests based on Chloe's user persona (Figure 5.2). As briefly mentioned before, defaulting the design to implement user localization saved the user time from typing in their location. Maps assist with retaining hurricane risk information that may be too abstract through words, and lastly, connecting the severity of the storm to a location. Altogether, these practices could be applied to designing applications for hurricane risk communication.

6.1 Defaulting to User Localization

Depending on the browser, if location sharing is activated, then arriving at the NHC home page should present information relevant to the location of the user. Users do not have to think about inputting their zip code to access information about an incoming hurricane, which saves them time. Readily seeing information that is based around the environment enables the user to think about the next step about what they want to do with that information. For the last thirty years, the basic advice regarding response times state that "0.1 second is about the limit for having the user feel that the system is reacting instantaneously" [22]. An interface that requests the user to input their location would add more time to see the result, and could also compromise the user's flow of thought which approximately lasts for a second. Communicating risks about an incoming hurricane should not lag because the user depends on that data to decide if the situation could be life threatening or damaging to personal assets.

6.2 Displaying Geographical Data through Maps

One of the goals for user persona (Figure 5.2) is to assess whether the near area would be flooded. All users depended on the map to check for this data. Even though the text-based information above (Figure 5.17) the map already states the category of the incoming hurricane associated with the location, which also elucidates flooding would occur, all users decided to skim this part. Instead, they associated the visual aspect of the map with the task of searching if a region would be flooded. Maps assist with understanding complex hurricane information, and also provides a larger context for the user. Now, the user can see not only the given area, but regions nearby that could also be important, especially if someone is planning on travelling.

The surge flood map also separates areas based on water depth in feet. Right away, the user can see the severity of flood for all regions. From there, the user could choose to focus on a specific area, and check for more information. As opposed to a textual format, the user would have to read and process the information linearly, word after word. Similar to defaulting to user localization, maps save users time when they are looking for the fastest way to understand what kind of incoming hazards would occur within the area. Maps make geographical data more understandable as opposed to textual data.

6.3 Communicating Warnings Messages Based on Locations

Different from communicating geographical data through maps, warning messages defer more to a textual format. As referenced earlier, all users commented on the information hierarchy of this section, which is right above the map. There are multiple types of information that are arranged together, one is a paragraph, the others are data points with text labels, and a video with a description. When communicating warning messages through text, a headline should be provided to contextualize the relevance of these various warning messages back to the location. Otherwise, if this step is not processed, the user would have a harder time contextualizing and making sense of the warning messages to the area of interest.

7 Conclusion

Hurricane risk communication is an expansive field that utilizes various mediums to relay weather warnings and alerts to the public. The NHC home page is a major component for hurricane risk communication in the United States, but the current design of their home page does not account for the laymen. For this thesis, in order to design an appropriate system for the NHC homepage that caters to the general public, human-centered design methods are applied in the process. After interviewing hurricane survivors and witnesses, a list of opportunities and insights were discovered and presented to an NHC group. One of the opportunities that they called attention to is user localization.

Designing for user localization with regards to the NHC home page consisted of following these human-centered design methods: user interviews, conducting competitor analysis, developing user personas, sketching low-fidelity ideas, designing high-fidelity prototypes, user testing, and design iteration. Users tests were conducted based on one user persona, and all testers successfully completed the tasks assigned to the persona. Their one complaint is the information hierarchy associated with the warning messages, which was lacking a headline. Their suggestions were considered and applied to the design.

Three generalizable design principles were discovered when designing for integrating user localization into hurricane risk communication: implementing default user localizations, utilizing maps for regional awareness and clarifying geographical data, and providing a central headline to encompass all warning messages.

Other government websites like fema.gov and ready.gov have standardized designs, and they fall within the scope of risk communication. Now, with climate change looming over the world, hurricanes and tropical cyclones can worsen because the increase in global temperature warms the ocean, providing more energy to exacerbate these storms [23]. Hurricanes are one of the most expensive disasters in the United States. Katrina alone dealt $170 billion dollars in damage [24]. Even if the purpose of the NHC is reserved for the academic and scientific community, the NHC is still listed as one of the most visited sites when searching for hurricane information, thus the public becomes the audience too. Designing the NHC home page for the public interest becomes a priority and should consider user localization to contextual individual user experiences.

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Appendix

NHC User Localization - Design Prototype
https://www.figma.com/file/b2bmkhPZQAcdATQKF73Ksw/NHC-User-Localization-Design-Prototype?node-id=0%3A1