

RAMBLE

Making walking safety a social focus.

MHCI+D
Capstone Project
2016

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01

Opportunity Space

A black and white photograph of a woman walking alone on a city street at night. She is positioned in the center of the frame, moving away from the camera. The street is illuminated by several overhead streetlights, creating a pattern of light and shadow. The background shows the dark silhouettes of buildings and trees.

Data collected by Gallup indicates that over the past seven years, 36% of U.S. residents reported feeling unsafe walking alone at night. This percentage increases to roughly 50% amongst women, city dwellers, and the socioeconomically disadvantaged. A significant 18-point gap in perceived safety separates the genders; 45% of the entire female population report feeling unsafe walking alone at night, as opposed to 27% of men (Gallup 2015).

While women are less likely to be the victims of street crime than men, they tend to be more afraid of it, which is often referred to as “the fear of crime paradox” (Pryor et al, 2013). However, the nature of women’s fear tends to be different from men’s fear in both its cause and effect: women are afraid of sexual violence and sexual harassment in particular, leading them to develop preventative strategies of distancing themselves in both space and time from potential attackers. Women also tend to be more aware of environmental cues and safety risks, which may contribute to them feeling less safe (Bianco & Lawson, 1997). Importantly, fear of walking is hypothesized to further restrict the freedoms of women (Pryor et al. 2013).

Additionally, the unique vulnerability and powerlessness that women face in society may largely contribute to their fears: women, both historically and currently, experience oppression, lack of democratic control, and marginalization in their communities, contributing to feelings of helplessness (Koskela, 2000). This “gendered exclusion” of women from particular spaces is tied to social constructs. Women’s mobility is restricted by the perception of certain spaces as masculine, a product of women’s historical exclusion from these spaces, and by the harassment and violence they face in some spaces. Notably, what this suggests is that women’s fear may be both a result and cause of women’s inequality (Koskela, 2000).

**45% of women in the US
reported feeling unsafe
walking alone at night**

GALLUP 2015

We realized that there was an opportunity to design an intervention addressing the specific fears that women face when walking alone. Our intention was to help women-identifying individuals in cities feel and be safer when walking. Residents of cities are more likely to use walking as a regular form of transportation than those in more rural environments (Saelens, 2003), and as described in the Gallup findings above, city dwellers tend to have an increased fear of walking alone, which may correspond with increased risk (Gallup 2015), making them a fitting population to target.

RESEARCH

02

How can we help women-identifying individuals *feel and be safer* when walking alone?

Research

Participant Profile

We recruited and conducted primary research with nine women-identifying University of Washington students (five participants for the diary study and semi-structured interviews, and three participants for the field study). We chose to focus our research specifically on college students because they are likely to walk routinely, and research has shown that female college students may be extremely perceptive and sensitive of the area around them, particularly at night, resulting in increased fear (Pryor et al. 2013). Furthermore, our interview with Natalie Dolci, UWPD Victim Advocate, suggests college students face a unique safety risk because college campuses are a “target rich environment” for people who are intentionally seeking out young women (e.g., people using Tinder presenting as undergraduate age); these individuals know that they will be able to find young women on campus while maintaining anonymity and the ability to come and go without scrutiny, leading to coercive or violent situations. From a data perspective, one final benefit of studying college students is that there is robust literature on perceived fear and walking amongst this population, which allowed us to better triangulate our findings.

While our secondary research rightfully cautioned against using a “one-size-fits-all” approach when trying to understand the fears that women face (Koskela, 2000), for the scope of this study, we realized that we would have the most access to UW students. As a consequence of our condensed research timeline, we limited our research participants to that demographic and did not have a representative sample of any other subpopulations of women. We recognize that we are now limited in our ability to generalize the efficacy of our design solution to other populations, but although we exclusively studied UW students, we see this as just a starting step. We believed that through our conversations with college students, we uncovered insights that ultimately informed a design solution that is suitable for other populations as well.

Literature Review

Our literature review exposed us to a set of common themes, including the influence of environmental factors on women’s feelings of unease and the notion of perceived fear versus actual fear.

Environmental Factors**CPTED**

Informed the Crime Prevention Through Environmental Design component of Ramble

There are different types of environmental factors that may signal to women that there is heightened risk of walking in a certain area. These can be, what researchers refer to as social incivilities, physical incivilities, and properties of the built environment. Social incivilities are disruptive social behaviors (e.g., public drunkenness, panhandling, begging), whereas physical incivilities refer to disorderly physical surroundings (e.g., litter, graffiti, abandoned buildings) (Loukaitou-Sideris, 2006). Features of the built environment can also contribute to fear by influencing visibility of potential threats and/or ability to escape.

Perceived Fear vs. Actual Fear**CPTED**

Safety can be divided into two categories: objective and subjective safety. Objective safety refers to the occurrence of criminal offenses, such as theft or burglary whereas subjective safety refers to the perception of security (Ruijsbroek et al, 2015). This distinction is important because, regardless of whether an actual threat exists, perception is what directly impacts one's actions and motivation. For instance, if people perceive an area as unsafe, they tend to walk less (Hong & Chen, 2014).

Perceived safety stems from many factors including social and environmental incivilities, and one's perceived probability personally becoming a victim. Perception of safety of a given location strongly corresponds to how well one knows and feels at ease with the surrounding environment (Loukaitou-Sideris, 2006). Interestingly, there is a significant lack of correspondence between citizen's perceptions of crime and official crime statistics: Walkers tend to downplay local levels of crime relative to city-wide or national levels (Forde, 1993). When outside a familiar environment, judgments about safety tend to rely more on preconceived ideas about a place and its occupants and cues from present social behavior and the physical surroundings (Loukaitou-Sideris, 2006).

Popular Media Scan

In our competitive analysis, we began by investigating media resources - news articles, UWPD emergency alerts, and the like - in order to learn more about public opinions regarding existing solutions in the industry. In order to supplement this research, we conducted a more in-depth popular media scan exploring how the local media covers the topic of sexual assault.

A significant number of articles discussed sexual assaults occurring in the University District. The UWPD released a total of 24 crime alerts over the past year, six of which contained references to sexual assault. These six instances are shown below, plotted alongside the amount of the local media coverage of sexual assault. As shown, almost all of these references were published in the aftermath of a sexual assault. Of course, this coverage includes news about the event and its effects, but this is also the period when the majority of preventative and educational articles are published. In other words, there seems to be a trend indicating that whenever an assault occurs, there is a

flood of corresponding articles both about the specific incident, but also about preventive safety measures women can take in order to protect themselves. This trend illustrates an education cycle that is highly reactive instead of preventative. By the time the media is sharing information about how to be safer in the local environment, it has already become an issue. We believe that the dissemination of educational material should not be reactive, but instead should be readily available and part of a broader, normalized conversation surrounding women's safety.

Subject Matter Expert Interviews***Daniela Rosner and Tari Nelson-Zagar***

In order to understand how the construction of urban and digital spaces affect women's perceived and actual safety, we spoke with Human Centered Design and Engineering faculty member, Daniela Rosner, as well as Seattle Neighborhood Group Senior Program Manager, Tari Nelson-Zagar. The interview protocols we used can be viewed in Appendix A.

Our interview with Tari Nelson-Zagar made us realize that our final design solution should be cognizant of the fallibility of anecdotal information and crime data. Avoiding errant information requires designers to frequently check personal biases and maintain good relationships with the user population under study; as designers, we should also take the cultural norms of a community into account before imposing solutions. In addition to this piece of information, we learned that our solution should consider features of the environment that may have different safety and surveillance concerns. Issues of safety are different in private, semi-private, semi-public, and public zones, especially where these zones overlap. Additionally, Tari also discussed the notion of "Community Activation." In the Crime Prevention Through Environmental Design (CPTED) realm, this term refers in part to encouraging community members to "work together to ensure each other's safety."



Daniela Rosner
HCDE Faculty



Tari Nelson-Zagar
Seattle Neighborhood Group
Senior Program Manager

CPTED

Daniela Rosner worked on project that explored how "GIS-routing might be designed to emphasize guided wandering over destination-oriented travel," and this work led her to caution us against contributing to stereotyping and stigmatization of neighborhoods or the people who live there. Additionally, if our solution were to make use of crime data, we could use that data in a way that exposes stigmatization, rather than contributes to it. These insights ultimately caused us to avoid map-based, route-planning centric design solutions. Daniela also helped us shape our diary study protocol by suggesting that we should have participants take photos during their walk because they won't be able to write during the walk. These photos could then be used during the follow-up interview to help participants relive their experiences with us.



Gillian Wickwire
UW SafeCampus
Threat Manager



Natalie Dolci
UWPD Victim Advocate



Gailyn Perrin
Taekwondo Instructor
Self Defense Expert



Informed the social media and reporting components of Ramble



Informed the safety tip component of Ramble



Gillian Wickwire and Natalie Dolci

We also met with UW staff members tasked with assessing and preventing violence on campus. These individuals include Gillian Wickwire, the UW SafeCampus Violence Prevention Response Program Threat Assessment & Management Specialist, and Natalie Dolci, the UWPD Victim Advocate. Natalie Dolci impressed upon us that our solution must be simple, and cannot require much thought or action from a user in a threatening situation; she cited a executive functioning failure as the basis for this suggestion. She also discussed the bystander effect and the idea that if our solution attempts to provide women with alternate, that is, safer, walking paths, then we should consider factors such as open businesses, traffic flow, and possible witnesses. She also talked about the fact that many people are not utilizing existing safety services like Husky NightWalk or mobile applications, but, of the products that are being used, the most impactful solutions are ones that lower the threshold so more people report instances. Gillian Wickwire echoed Natalie's sentiments, stating that our solution would be significantly better if it was part of a larger system bringing about broader societal changes.

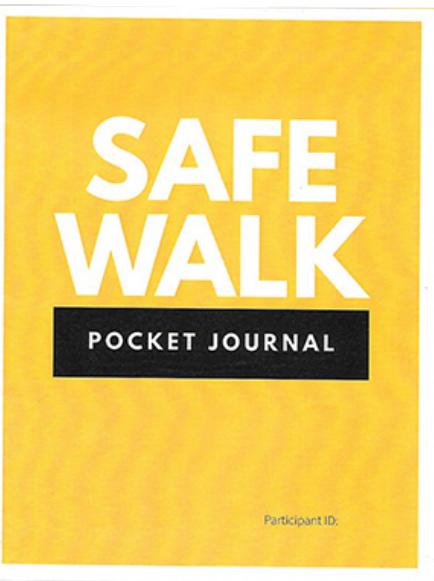
Primary Research

After examining existing literature regarding our problem space, we transitioned into the primary research phase of our project in which we sought to uncover original insights that could shape future design solutions. Our primary research efforts included subject matter expert (SME) interviews, field research, diary studies, and semi-structured interviews.

Diary Studies

We viewed our diary study as a substitute for direct observation. We hoped to better understand what causes women to feel safe or unsafe when walking alone at night, as well as the behaviors they engage in to mitigate feelings of unease, without directly intruding on these activities. The diary we created for participants was designed to function as a design probe that would increase the participants' awareness of their own personal walking habits prior to the semi-structured interviews; we believed this strategy could help us avoid conducting interviews that would garner superficial insights. The diary we used can be viewed in Appendix B.

We hoped the digital and physical artifacts of the diary study would function as recollection tools and points of discussion in our eventual interviews, a method known as photo elicitation. Recommended by subject matter expert, Daniela Rosner, photo elicitation is a method used to evoke memories that are difficult to recall through verbal prompts. We hoped to exploit this method in order to surface different, and more personally contextual information.



Diary study participants filled out paper journals about their walking practices and tracked their walks using a mobile application.

Gailyn Perrin

We then reached out to Gailyn Perrin, a Taekwondo instructor and self defense expert, to learn more about what individuals can do to protect themselves. Despite being a martial arts instructor, her self defense seminars focus heavily on teaching the nonphysical aspects of self defense: the importance of awareness, body language, boundaries, and projecting confidence. She emphasizes that preparedness and confidence are key factors in lowering your chance of becoming a statistic, and that this confidence is related to how much exposure and knowledge you have. She also teaches the importance of listening to your intuition. It's common for people to disregard feelings of unease, but she teaches that human beings have developed senses to protect themselves, and we should learn to pay attention to them. Subsequently, taking action on those feelings, not ignoring them, is a significant factor in keeping oneself safe. Another salient take away from our discussion with Gailyn was about the general tone of her seminars. She frames the entire session in a fun, lighthearted way. She believes that people want to remember positive experiences, information learned in a positive setting are more likely to stick with you. In the extreme cases, being able to share and discuss the situation is beneficial to heal.



Semi-Structured Interviews

We conducted semi-structured interviews (protocol in Appendix D) in order to gain an in-depth understanding of our target user's perspective, needs, and desires. This methodology incorporated a structured set of questions, with the flexibility to ask clarifying or follow-up questions. While the diary studies helped us identify the ways in which women negotiate space, interviews gave us the opportunity to ask specific questions regarding data collected in the diary studies. In addition to providing an opportunity to clarify diary entries the interviews allowed us to better understand the nature and experiences that contribute to participant's fears as well as how they communicate with others about them.



Field Study

We conducted field research (protocol in Appendix C) in which we walked with our participants along a route that they regularly took at night and elicited real-time, contextual information regarding their walking practices and feelings of safety.

During these walk-alongs, we observed what routes our participants took and what kinds of behavior they exhibited, asking them questions about it along the way. This allowed us to better understand what contributes to feelings of safety, what behaviors they engage in to feel safer (e.g., avoiding certain streets), and if they any existing walking safety products (e.g., Companion app or carrying mace). Field research allowed us to observe our participants in a natural context, with their organic behavior when walking at night. Unlike our interview and diary study, this field study gave us the advantage of witnessing what participants actually do, not just what they say they do. Additionally, observation allowed us to be in the actual environment and so we were able to notice problems or behaviors that participants may not be attentive to, and ask them about it on the spot; for example, one of our participants took an extremely inefficient route to get to her final destination, but did not realize it until we inquired about it.



CPTED

Key Insights

Insight

Our participants feel safer around and seek out the presence of other people. For example, they often called or texted friends or family when walking alone at night. However, our participants expressed discomfort reaching hesitant to reach out friends and family for fear of being burdensome or causing them to worry. This hesitation to communicate also extends beyond the context of the walk.

Implication

This finding made us realize that there was an opportunity to facilitate easier communication of fear, both during and beyond the walk.

Insight

Features of the built environment impact perceived and actual safety

Implication

We decided that our design solution should enable women to impact their surroundings by making their concerns known to organizations that are capable of improving pedestrian safety.

Insight

There are difficulties assessing potential threats, as well as fear of unnecessary escalation. Research participants expressed concern regarding over-reacting to situations where they felt unsafe, not only for fear of expediting potential conflict, but also for social reasons; reacting in a defensive manner when it proves unnecessary can be an embarrassing experience, as well as potentially offensive for the person who is perceived as the threat.



Implication

Our design solution should help women feel confident in their ability to assess risks.

Competitive Analysis

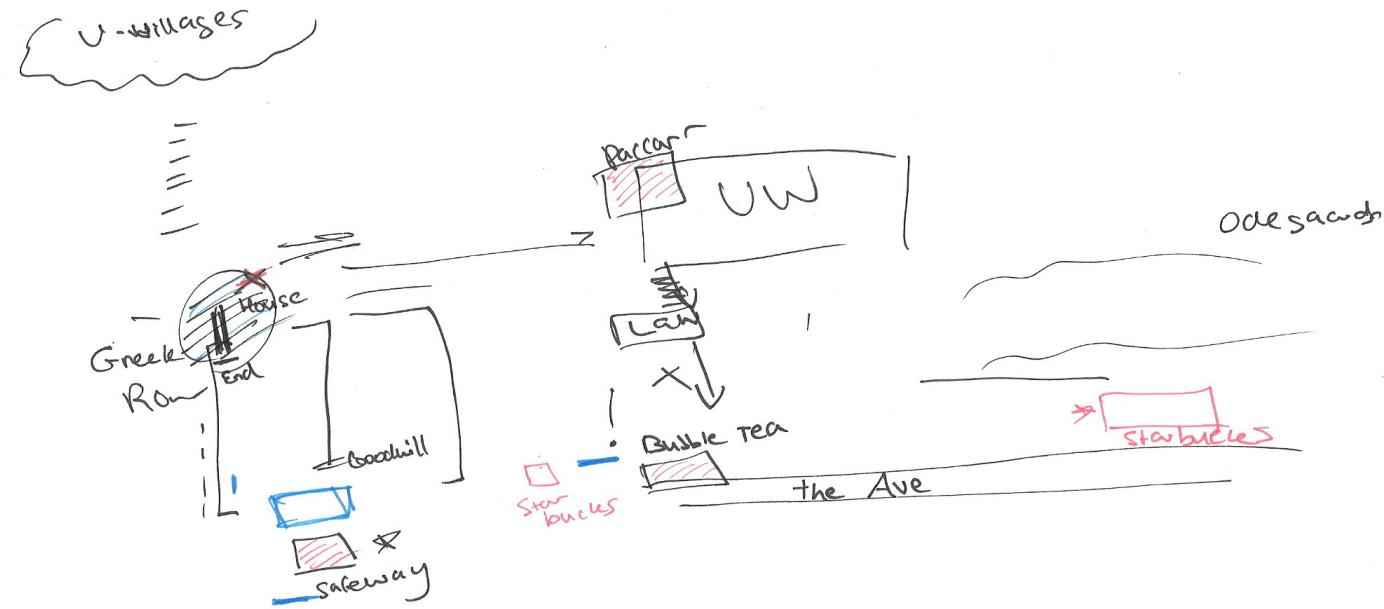
In order to better understand the landscape of existing solutions, we conducted an investigation of products, services, and programs intended to promote walking safety, examining their target audiences, feature sets, and opportunities for improvement.

We conducted a survey of roughly thirty existing products, both directly and tangentially related to the issue of walking alone, and categorized them into seven distinct groups based on features. The categories are as follows:

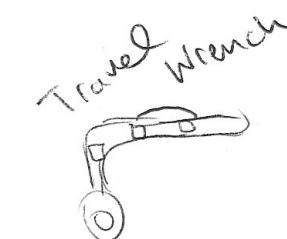
- Risk and incident prevention, for example, preventing active shooter scenarios
- Apps specifically designed to encourage safe walking practices
- Sexual harassment and assault prevention
- Apps that enable users to share their location, or monitor the location of another individual
- Apps that include crowd-sourced elements
- Physical devices
- Apps that utilize crime data

There are a number of ways in which the existing landscape of products were not sufficiently addressing the needs of our target users, but the most obvious failure across a majority of these products is that they seemed to underestimate the hesitation that women-identifying individuals may face in reaching out to others for help. Our research participants were concerned about taking any action that may be perceived as an overreaction. For example, they described being reluctant to contact emergency services in situations in which they aren't entirely confident that they were in danger. However, many of the existing apps we analyzed seemed to operate on the conceit that they should provide a streamlined system for contacting the local authorities. We believe that features like this are likely to go unused outside of situations in which a woman is already in danger and unable to protect herself and thus are not comprehensive enough of a solution. Similarly, our participants also expressed a hesitation to communicate fear, even to friends and family. Apps that recognize the need for "levels of escalation," so to speak, encouraged users to reach out to friends and family in situations in which they feel uneasy. While these features may run less risk of feeling like an overreaction, our participants were extremely preoccupied with not wanting to burden or worry others, especially in scenarios in which the perceived threat far outweighed the actual threat. We believe that a product we create should not make the same assumptions about women and their willingness to ask for help that our competitors have made. The full competitive analysis of our top competitors can be viewed in Appendix G.

Informed the walking partner component of Ramble



= danger
 = frequently used



Participants spoke to us at length about their experiences feeling unsafe walking, including the environmental factors that contribute to these feelings, products or tools they have experience with, as well as their lack of confidence in assessing risk.

IDEATION

03

Ideation

The first stage of ideation was to generate as many unique as possible. To guide us through this process we used three different ideation methods each approaching our problem space from a different angle.



Individual Ideation

Unstructured / Individual

We started with idea generation, beginning with individual ideation. This exercise was meant to be mostly unstructured, but we also created a series of prompts of things to consider in order to help get past any ideation obstacles. These included straightforward prompts like considering different experience stages or stakeholders and also prompts meant to stretch our ideas: like worst case scenarios or wish list devices. This exercise resulted in 130 initial ideas to start our ideation discussion for our next methods.

Concept Generating Matrix

Structured / Group

Our second method was a concept generating matrix where we sorted our initial ideas into the different stages of our experience map and then we used it to guide us to more ideation in each of these stages. Forcing us to exhaust ideas for the entire experience instead of focusing on the few stages that are easy to ideate for. After plotting our initial ideas according to the stage of walking experience, we realized that most of our ideas were concentrated on the stages that happened during the walk, surfacing the need to spend more energy ideating on the pre- and post-walk stages, including ideas that span the planning, reflection, communication, and behavior change phases.

Our experience stages were: Origin, Planning, Unease, Identifying Source, Assess, Decision, Reaction, Destination, Reflection, Communication, Behavior Change

IDEATION

Principles to Opportunities

Structured / Group

Our third generation method was a structured principles to opportunities matrix where we based our brainstorming on our design principles, focusing on individual opportunities, system opportunities, and strategy opportunities. This exercise helped us bring out some overarching system ideas and business strategy ideas that were missing from our other ideation methods.

Our generation methods yielded a total of 168 ideas, so our next step was to start analyzing and refining them.

IDEATION

Concept Synthesis

Unstructured / Group

From these refined ideas, we began pulling out aspects of what was making these good ideas, and then moving into a concept synthesis where we started selecting our favorite ideas and mixing and matching ideas and aspects to refine them into even stronger ideas.

Concept Sorting

Unstructured / Group

We began refinement by doing concept sorting, grouping all of our ideas together into main directional themes: like "community conversation" or "aiding risk assessment". Then refining further, by voting on ideas that were our favorites to continue to the next stage.



Our initial concepts varied from those that addressed in-the-moment concerns of risk-assessment, early warning sensing, and companionship during the walk to broader solutions attempting to address the underlying issues that perpetuate the problem.



CONCEPT 1 **Proximity Sensor**

Equipping a physical device with proximity sensing capabilities to alert a woman, and potentially authorities, when a stranger is too close to her, thereby augmenting her ability to assess and respond to potential threats.



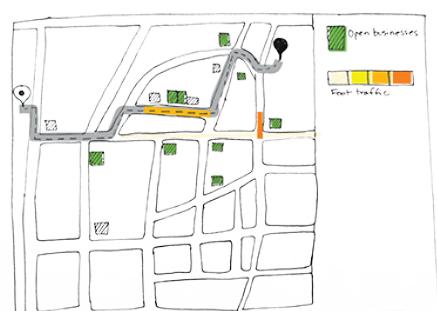
CONCEPT 2 **Environmental Risk Reporting**

Providing female-identifying individuals with a system by which to catalogue and report unsafe features of the built environment to entities capable of fixing them.



CONCEPT 3 **Incident Sharing on Social Media**

An anonymous social media platform for women to share their walking experiences with each other and their community at large. In addition to facilitating conversation around these experiences, this tool could help law enforcement identify and address trends.



CONCEPT 4 **Connecting Pedestrians & Businesses through Contextual Suggestions**

Augmenting women's current practice of strategically picking the paths they will traverse by providing them with a mobile application that combines data about foot traffic, open businesses, the built environment, and potential threats in the area, to suggest a safe route.



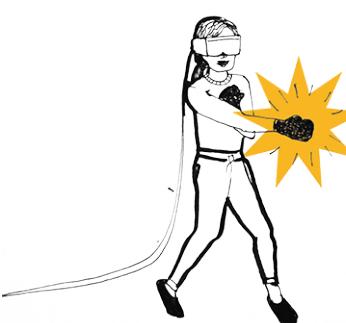
CONCEPT 5 **Anonymous Walking Pals**

A mobile application that gives female-identifying individuals a mechanism by which they can feel like they are in the presence of another person without feeling like they are burdening friends and family. This is achieved by matching two anonymous solitary walkers together and allowing them to remotely monitor whether or not the other individual safely reached their destination.



CONCEPT 6 **Gradational Help Request**

Providing women with a tool (mobile application or physical device) by which they can indicate varying levels of unease so that they can reach out for help without feeling obligated to escalate the situation by calling 911.



CONCEPT 7 **VR Defense Training**

A VR game that gives women practice and confidence about their ability to respond in the event of an assault.

Continued Ideation

After receiving feedback on our initial seven concepts, we set out to stretch each concept a little further.

Action Verbs

We tried a method called Action-Verb, coined by Ellen Lupton in a book titled Graphic Design Thinking, to ideate on new dimensions of our initial concept directions. In a group ideation session, we made a list of action terms (e.g. magnify, maximize, minimize, combine, substitute, put to another use, re-arrange) and then through sketching and thinking aloud, tried to think of how we could apply those terms to our ideas. For example, by applying the term “substitute” to our Virtual Reality Self-Defense Training concept, we came up with the idea to use the VR game as a tool to help men empathize with the female walking experience. While a quirky process, we found the Action-Verb method to be tremendously useful for building off of and diverging from our existing ideas.

Brainwriting

Throughout our discussions, we were interested in the idea of a neighborhood watch to include others who care about the safety of the neighborhood into the walker's experience. To determine how this could actually be implemented, we formulated a series of five prompts, each focusing on a different aspect of how it could be implemented, and we then performed a brainwriting session. Each prompt was written onto a sheet of paper and then two of us did five minutes of ideation on each prompt, sketching our ideas onto that sheet of paper. Then, without discussing the sketches, we passed the pieces of paper to each other. The next person could review what was already drawn, iterate on the existing sketches, or add any additional ideas they have. At the end of this process, we had a dozen ideas for each stage and then worked together to piece together a coherent overall experience.

Stakeholder Map

Conducting a stakeholder analysis allowed us to understand current attitudes regarding safe walking practices. Distinguishing between primary, secondary, and key stakeholders allowed us to understand the relationships between the relevant parties involved in solitary walking, and how their interactions could be facilitated through our potential design interventions. We realized that in addition to walkers having a stake in the physical environment being and feel safer, entities like businesses could also benefit from data collection and practices that increase safety.

Storyboards

Storyboarding served as a mechanism to describe high-level concepts as opposed to demonstrating low-level interactions (like the flow through a given user interface, for example). We attempted to convey the key requirements of our concepts in a quick and cheap manner that would be difficult to understand in a text format. Our storyboards allowed us to describe the characters (the relevant stakeholders), setting (the environment or context in which the interaction takes place), sequence (what leads a person to use a design and the steps involved in completing tasks supported by the design), and satisfaction (motivation and end result) derived from our proposed concepts.

Interaction Flows

Creating interaction models allowed us to identify generalizable features or experiences provided by our design concepts. Our models defined a series of steps a user would need to take in order to complete a given task.

Top Three Concepts

Our concept refinement phase resulted in three concepts. Concepts 1 and 2 were more fleshed out and considered prior concepts, while Concept 3 was shaped from the latest round of ideation methods.



CONCEPT 1 **VR Defense Training**

Our VR Self Defense Training concept aimed to educate and empower women in a fun and personalized way.

CONCEPT 2 **Business-Pedestrian Coordination and Environmental Reporting**

This concept sought to combine the route planning of our business-pedestrian connection concept with our environmental risk reporting.

CONCEPT 3 **Neighborhood Watch 2.0**

This was a new concept generated from our a later ideation process of Brainwriting. Seeking to connect more to the in-the-moment feelings of unease and wanting to help women feel “watched out for”, this concept would link a button press on a mobile device with local residents and an exterior beacon system. Pressing the button would be answered by lights indicating the walker was “not alone” and the walkers location could also be tagged if police intervention was needed. Our final concept (a button press linked to another walker, signalling unease, answered by a vibration), can be seen as a more feasible version of this idea.

Final Design Concept

Ramble is a mobile application that makes walking safety a social focus. Our application bridges the real, in-the-moment need for women to feel “watched out for” with the broader scale social support needed for validation, education, and advocacy.

The design concept borrows the strongest aspects from many of our prior concepts into a solution that used the central experience of walking alone as a jumping off point to collect data, advocate for environmental change, educate, and increase conversation.

EVALUATION

Prototyping

Once we converged on the basis of our final concept, we put a paper prototype of our wireframes in front of users to both validate that we were headed in the right direction overall and to seek input on the details. Specifically, we had participants evaluate the major components of our concept, including the walking experience, the social channel, and the integration of education.

Research Questions

Concept evaluation was guided by three overarching research questions:

1. What is the desired level of interaction during the walking experience?

What is the minimum level of interaction with their partner that users need in order to feel adequately “watched out for” while walking alone? We were particularly interested in finding the least involved interaction needed because, for safety purposes, it is important that our solution minimizes distractions while walking. We tested three levels of interaction between partners: (1) walking partners could monitor whether each other arrived home; (2) walking partners could monitor each other’s in-walk progress towards their respective destinations; (3) walking partners could signal feelings of unease to each other during the walk by pressing a volume button. We were also interested in understanding whether partners wished to continue the communicating after the walk. Lastly, we wanted to assess what participants desired or expected to happen to data collected during the walk (e.g., did they want this information to be aggregated and sent to police?).

2. What form and culture should the social media channel have?

Who do users want to be a part of their social media community (e.g., anyone within a certain distance, exclusively college students, exclusively women)? What level of anonymity between users is desired? What concerns do users have about safety and sensitivity of the topic on a platform like this? How do users want to interact with stories shared on a social media channel (e.g., upvote, provide more nuanced reactions, comment)?

3. What type and form of education are users most perceptive to?

Do users find information about nearby incidents or local data useful? How should the application incorporate safety tips (e.g., associated with incidents reported by users, exist as a passive list of tips that users can bookmark, appear in the social feed alongside polls)? Should safety tips always come from the system? Would users like to send safety tips to their walking partner?

Methods

Participants were four female UW students recruited from the UW Free & For Sale Facebook group.

We prototyped the experience in two ways: a simulation of fear while walking alone and through hands-on activities with a paper prototype of our application. Participants first interacted with the paper prototype, where they went through a sequence of being matched with a theoretical walking partner and went on two five minute walks on campus. In order to better contextualize this experience, we asked them to think about a walk at night that they frequently do and inquired about something they tend to be afraid of on that walk. On both walks, they were instructed to be on the look-out for a girl wearing a bright yellow raincoat, and to imagine this was the thing they often feared. On the first walk they were not able to communicate with their partner, just monitor whether each other reached their destination. On the second walk, they were told they could communicate to their partner during their walk if they felt uneasy. This activity was intended to create real feelings in an otherwise artificial situation in order to elicit information about how it felt to be connected to another person in this experience.

After the walking activities, we presented participants with paper prototypes representative of other aspects of our application, and asked them questions





like who they wanted their walking partner to be, their expectations of the social channel, and tried to gauge their feelings towards tips and locally-sourced incident report data. We adopted a semi-structured interview format because although we had prepared a rigorous set of questions, this format gave the experimenter the ability to adapt to participant feedback and probe further on certain topics, or change the order of questions as appropriate.

The comprehensive testing protocol can be viewed in Appendix E.

Findings

Testing our prototype resulted in 4 key take-aways.

1. Validation that the Walking Partner alleviates concerns of burdening or inconveniencing others.

In earlier primary research, we found that participants had a desire to feel the presence of another person during their walk, by for example, calling friends or family during the walk. However, they felt concerned about the burden this placed on others. Based on these findings, we created the Anonymous Walking Partner feature. So this was the biggest question mark for our research at this phase- does the anonymous walking feature actually provide the feeling of the presence of others without the concern of burdening another person? Fortunately, we found that this was a good solution and that we didn't need to fundamentally change it. Before directly asking or prompting any participants on about this notion of not wanting to burden friends/family, two of them brought it up entirely on their own as a positive of this feature and when directly asked, all four enthusiastically agreed that this was an effective solution.

This quote is in reference to the walking activity during the study where through our prototype, she was able to communicate to her partner when she felt unsafe, she said: "I like how you can keep track of each other's progress and you don't have to rely on friends...your friend isn't burdened to always be there and you have a comrade."

Further, participants strongly and unanimously preferred having another human as the walking partner over an automated service, emphasizing the comfort added by the presence of other people.

Design Implication: The anonymous walking partner is an appropriate solution to this problem. Given that having a walking partner is comforting, designs should highlight that the user's partner is a real person.

2. Presence of partner is desired during walk, but interactions during and after should be minimal

Resoundingly, all participants preferred being able to reach out to their partner during their walk to let them know they felt uneasy and found the fact that there was another person there as their partner (and not say an automated machine) to be comforting.

While we thought that users might want to be able to chat with their partners after the walk, especially if anything notable happened on their walk, ¾ of our participants actually did not want the option for direct chat at all. For some, even so much so that the knowledge that they might have to engage in a 1-on-1 chat, could be a barrier to them using the app entirely.

Design Implication: Partners should only be able to interact via button presses during the course of a walk. Further, the interaction should be made to be as convenient and efficient as possible.

3. Personalized and gradational escalation is desired

Our next findings are about the way the app should handle escalation. 3/4 participants suggested the volume buttons correspond with varying levels of response. For instance, one participant suggested that one button press could mean "I feel uneasy," 2 button presses could enable you to call your partner, and 3 presses could automatically call 911.

As for what should happen if the user doesn't arrive home, all of our participants were concerned about sending off false alarms and 3 out of 4, unprompted, recommended the ability for the user to customly set what happens in that situation. Customized preferences might include choosing whether it is an emergency contact who is notified or the police, and deciding if a certain number contact attempts should be made before involving these other entities.

Based on this finding, we decided to add two levels of escalation during the walk (contacting partner with one button press, or police with rapid press) and personalized options if the user doesn't arrive home, such as selecting an emergency contact.

Design Implication: Provide two levels escalation (contact partner or 911) and provide ability to select emergency contact.

4. Actionable information is preferred over casual rants about incidents

Through the course of our evaluations we noticed a tension in our participants' stated desires, and we believe that these two quotes - prompted in response to questions regarding what content participants would like to see populated in a news feed - demonstrate this conflict in values well.

"I don't want to go on the app and read all of these horror stories...and then not want to walk at night anywhere."

"It's good if as citizens we have our own system. If we take more precaution, that could reduce what is happening."

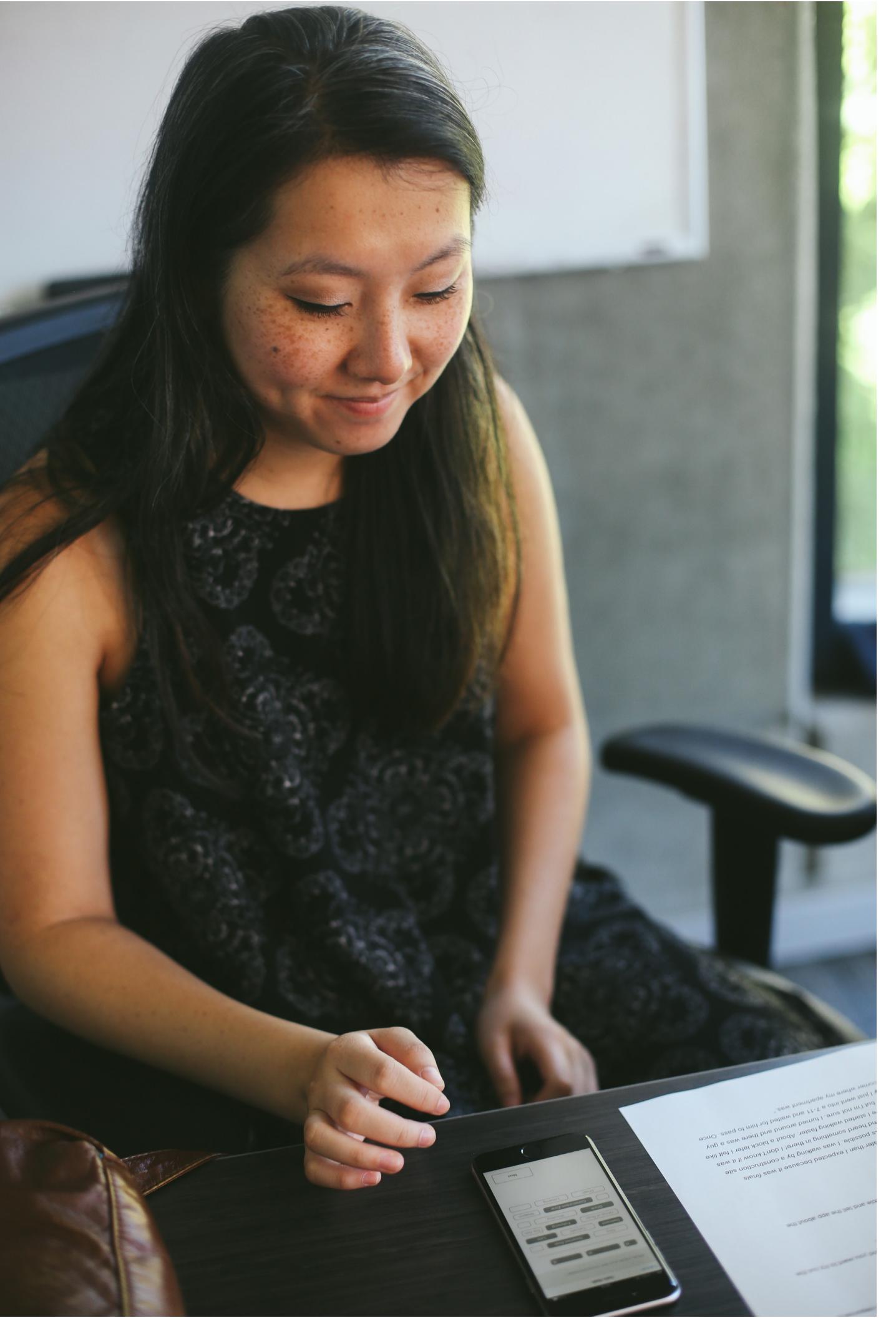
We realized we were faced with the following dilemma: Our participants recognized that ignorance is bliss, but also that knowledge is actionable. How do we give participants the actionable information they want without scaring them? Participants do not necessarily want conversational "social" content, but they also expressed the desire to avoid a stream of horrendous events. We decided to shape the content of the news feed so that it includes the following content.

User generated content that takes the form of a so-called "heads up" to other walkers in the area, as opposed to a forum for venting frustrations. We imagine that these warnings would be time-dependent - for example, "there is a man wielding a knife on 43rd" - and would therefore be inappropriate to present in a map based visualization because such a visualization would quickly become outdated. We view these user submitted warnings as not only being time-dependent actionable information, but also as being location-dependent.

In addition to user generated content, the news feed could also include educational safety tips and polls. This actionable information is not inherently time-dependent or location-based, and can be a bit more generalized - for example, here is a course of action to take if you believe you are being followed. Our research participants were very keen on this type of content, and we believe that if we balance this user generated content with this educational content, than we can avoid presenting our participants with a stream of horrendous events.

In a similar vein, we believe that the news feed should be providing women with the information they need in order to feel more confident when walking alone. We are not trying to terrify women and limit their agency even further. Although users expressed disinterest in engaging in casual conversations regarding unpleasant walking experiences, we spoke to Gailyn Perrin, a self-defense subject matter expert, and she stressed the importance of encouraging women to talk about said unpleasant experiences. We are going to include a "question of the day" type of prompt in our news feed that would hopefully spark these types of conversations. However, a user would have to opt into reading these posts by clicking to expand the question of the day. The content would not be immediately visibly on the social media feed, thereby avoiding a "stream of horrendous events." We also believe that the language and tone we use throughout our system will be instrumental in driving the conversation in a positive, empowering direction, as opposed to encouraging fear-mongering.

Design Implication: Balance user generated content with educational information. The social media feed should be empowering, not fear-inducing.



05

Usability Testing

Once we converged on the basis of our final concept, we put a paper prototype of our wireframes in front of users to both validate that we were headed in the right direction overall and to seek input on the details. Specifically, we had participants evaluate the major components of our concept, including the walking experience, the social channel, and the integration of education.

Research Questions

How understandable are the screen flows within our application?

Are there any conceptual disconnects in our sections?

What is appealing about our application to participants?

How intuitive is the unease button pressing and escalation?

Will users be confused by not having a map?

Overview

Using an interactive prototype created using InVision, we tested the application's usability and desirability by having one participant complete activities such as search for safety tips, reply to a report, and take us through a think-aloud exploration of the walking experience. The exact protocol used can be viewed in Appendix F. Our sponsor, Tom Iurino, advised us to write a paragraph - similar in tone to a newspaper article or blog post - describing Ramble. Because our prototype did not include an onboarding process and was devoid of significant visual design (it was still in the wireframe stage at this point), the paragraph was intended to prevent confusion which could arise during the evaluation session. The paragraph was read to the participant before the evaluation session began. Finally, in order to simulate an incident to report using Ramble, we had the participant read a story about an incident that occurred in the local area and then asked her to walk through how she would personally report the incident using our wireframes.



Wireframe from the Usability Test

Results

Generally Understandable Interface

Our participant was able to easily navigate our application and did not struggle to understand the various aspects of the application. She described the functionality of the News Feed and Safety Tips components in the manner we had intended, validating our design decisions.

Generally Desirable Content

Our participant echoed the sentiments of our concept prototype evaluation participants, stating that she would find the Safety Tips information included in the News Feed useful if this app actually existed.

Lack of Clarity in Walking Flow

We did not provide the participant with an onboarding process, nor did our prototype include an instructional overlay for the Walking Partner feature. She expressed confusion over who her walking partner would be and how she would communicate with them.

Guerilla Testing

Guerilla Testing with Subject Matter Experts

While filming follow-up testimonials from two subject matter experts, we guerrilla tested our high fidelity interactive prototype made with Invision. We were interested in eliciting feedback regarding Ramble's general desirability, as well as surface aspects of our design that contradicted with our subject matter experts' understanding of the problem space.

Tari Nelson-Zagar

Tari's guerilla test was notable because she voiced concern about the tone of the social media platform, stating that it could potentially scare or alarm users. She believed that our design to include tags as a mechanism for constructing incident reports was clever because the tags could utilize value-neutral language. Value-neutral language would allow users to discuss a space in constructive ways, which would in turn make it easier for official organization to implement substantive changes.

Gailyn Perrin

Gailyn believed our design solution was appropriately addressing the problem of women feeling uneasy when walking alone, but, like Tari, she cautioned us about being careful with our choice of language throughout the app. She advised us to construct unambiguous tips that could not be open to multiple interpretations.

Results

Our guerilla testing supported the efficacy of the tagging and incident reporting interaction flow and reinforced that this is a solution that could augment existing CPTED procedures. It also highlighted a concern regarding anonymity and whether predatory behavior could be mitigated by obscuring personally identifiable information. This made us cognizant of the importance of our UI screens clearly communicating that a user's identity is hidden and protected.



DESIGN

06

Visual Design

Brand Attributes

We developed a brand direction through a collaborative mood board, individual design rounds, followed by discussion and consensus for brand attributes.

We formed the look and feel for Ramble around the following attributes:

Positive, Lighthearted, and Respectful

Ramble uses a friendly and casual language like “Heads Up” and “Did you Know?”, along with bright yellows and subtle drop shadows to give light dimension.

Personality

Bright colors, highlight elements, individual elements like powerful female avatars.

Connected

Animations should feel smooth and natural and there should be continuity between main application features.



Card designs from the user interface of Ramble

Typeface

We selected two typefaces for the application, Source Sans and Montserrat. Source Sans is a nice, simple font that is easy to read on a mobile phone. It also has a more casual vibe, promoting the lighthearted feeling we wanted in our app. Montserrat is used for headers. It is a bolder font that pairs nicely with Source Sans while emphasizing the safety themes.

RAMBLE

SourceSansPro-Bold
#030303

ABCDEFGHIJKLM
NOPQRSTUVWXYZ

Montserrat-SemiBold
#4A4A4A

ABCDEFGHIJKLM
nopqrstuvwxyz

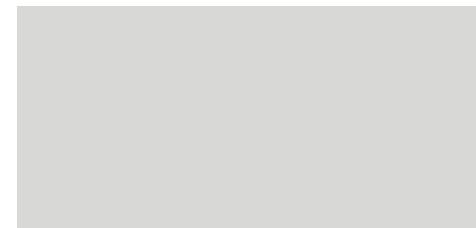
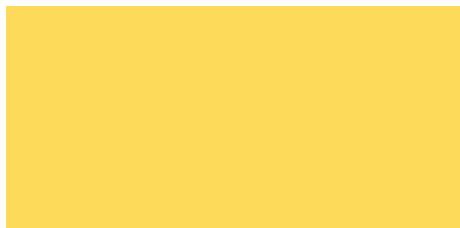
SourceSansPro-Regular
#4A4A4A

Colors

We selected the yellow and black colors because they are bright, bold, and confident, emphasizing the theme of safety, caution, and attentiveness.

Other colors were integrated to give the application more personality.

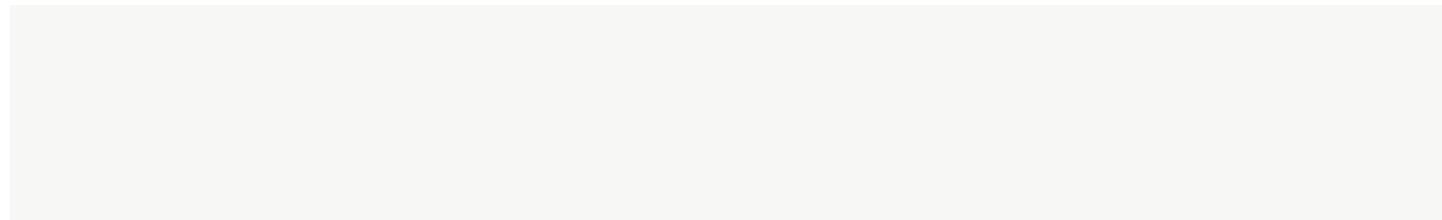
Basic Palette



Main Color
#FFDA5A

Gray
#D8D8D8

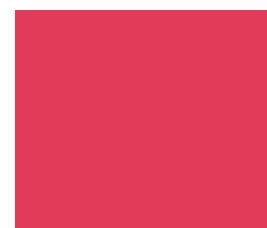
Black
#4A4A4A



Background Color
#F6F5F3



Blue
#337DFE



Raspberry
#E13F5A

Icons and Avatars

Our main icons were used in the navigation bar for the social media feed (called News), the walking partner feature (called Walk) and the Tips section (called Tips). To give each icon more personality and tie it to our look and feel, we added a yellow highlight to each.

Additionally we integrated avatars that users would be able to choose between, giving the walking partner experience more of a personalized feel. This was supported by concept prototyping feedback, where participants expressed some confusion over who their walking partner was and if they could be made to feel "more real". Avatars were designed after a diverse set of powerful historical and fictional female characters, intended to convey our brand attribute of empowerment.

Icons

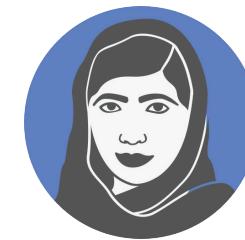


Main Icon Set



Other icons styles

Avatars



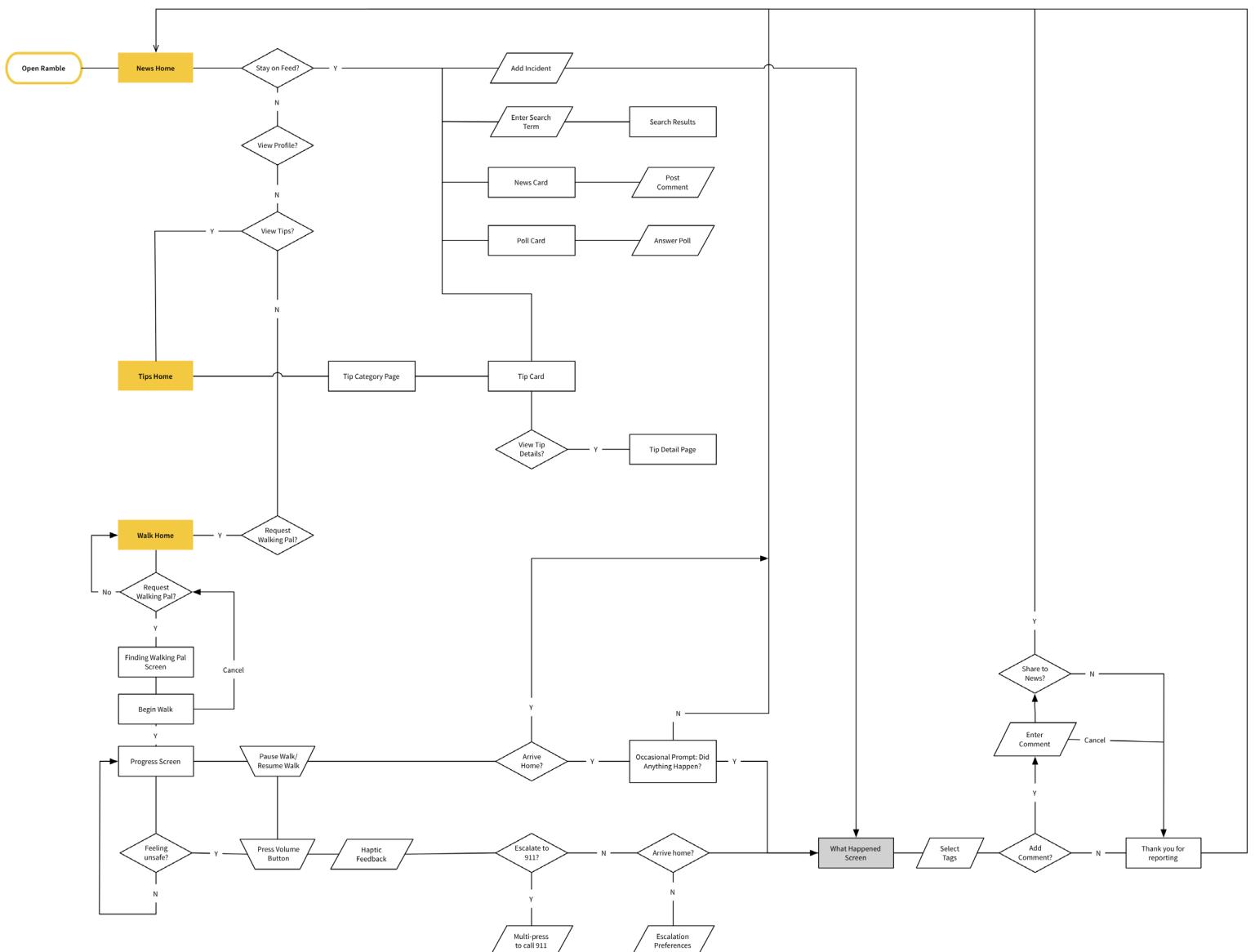
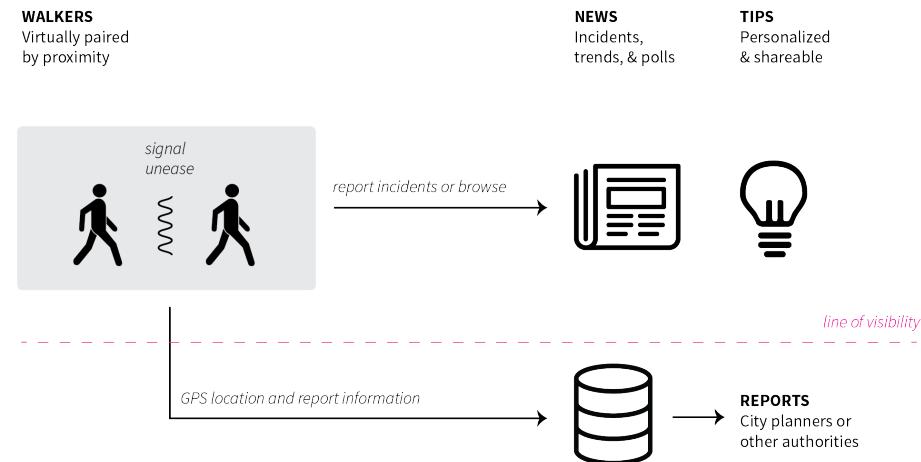
Design Specification

Our final solution is Ramble—a mobile app that makes walking safety a social focus, using partnership and community involvement to support women-identifying individuals through the fear and danger of walking alone.

We chose to create a mobile application for a variety of reasons. First, we wanted to create a product that would augment women's existing personal safety strategies, and our research revealed that our participants tended to carry their phones in their hands, or, store them in an easily accessible location. . Second, we wanted to create something that would be able to be utilized during all stages of the walk, which includes the walk itself, thereby necessitating a portable solution. Finally, we wanted our solution to be able to access a walker's GPS coordinates.

SYSTEM MODEL

A simplified model of our system shows walkers paired with an ability to signal their unease to each other through a haptic pulse. Walkers are then able to report incidents that made them feel unsafe to News, and also access tips. Meanwhile, data they have created from using the walking feature is stored and aggregated for reports that can be sent to city planners or other authorities.



USER FLOW

The task flow diagram above describes a user's possible paths through the Ramble application.

Walking Partners

Ramble connects single walkers together in order to virtually monitor each other's progress towards their respective final destinations.

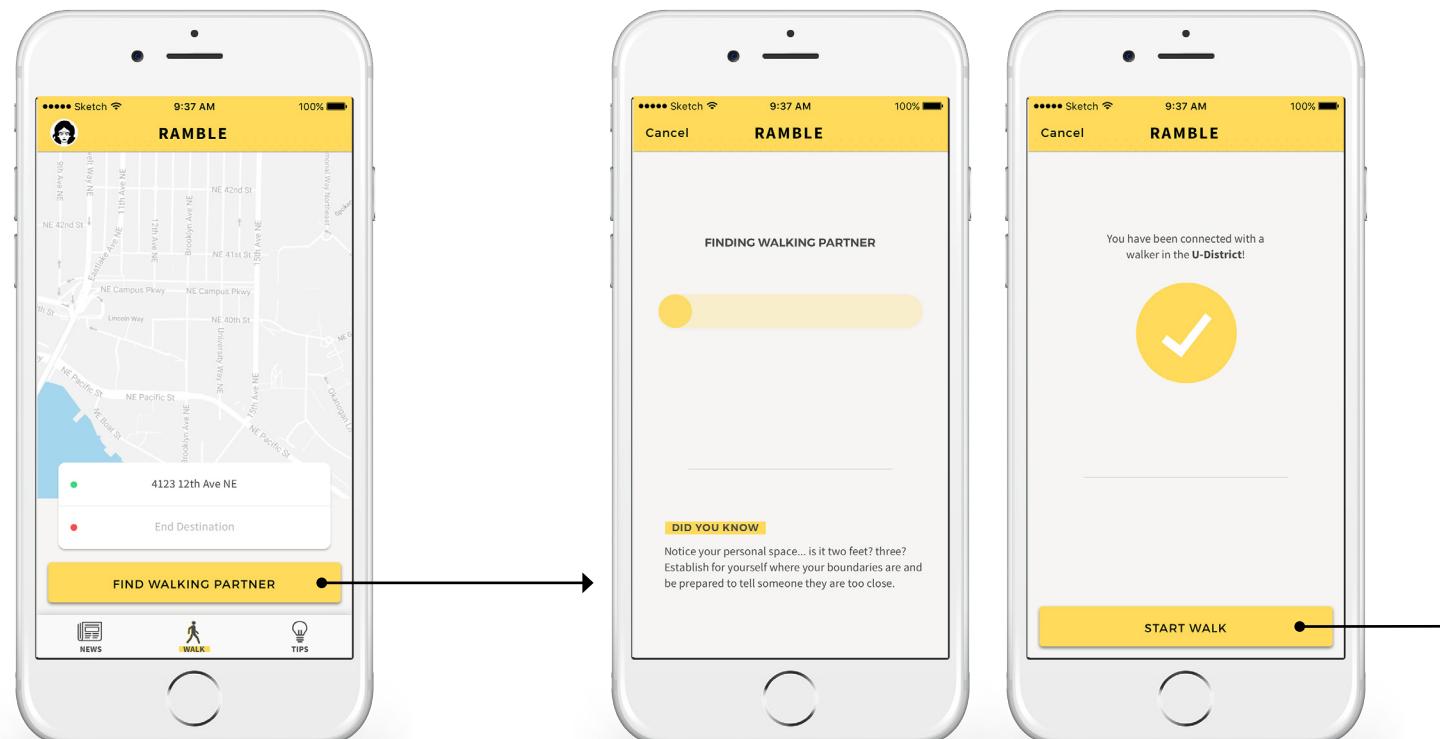
In our primary research, we found that participants had a desire to feel the presence of another person during their walk. However, they were reluctant to reach out, citing reasons like wanting to avoid causing friends and family to worry, feeling embarrassed about being afraid, and feeling insecure about whether their fears were justified. By connecting strangers who are both walking alone, Ramble provides walkers with the presence of others while simultaneously eliminating the concern of burdening loved ones.

Ramble keeps paired walkers identities anonymous, meaning walkers do not know each other's names or exact locations. Walkers only know when their partner has departed and whether they have reached their end destination. Personally identifiable information is hidden in an effort to reduce the potential for predators to use this information for harmful purposes. Participants who tested the prototype of our concept found comfort and value in the other entity being another person, as opposed to an automated machine. For this reason, we included humanizing details, including the region a walking partner is currently in, as well as a personalized avatar, further leveraging

the comforting power of having another person present.

Despite participants feeling safer when they felt less alone, we found a general silence around communication of fear to others. Ramble attempts to lower the threshold for women to express their fears around walking by allowing users to signal discomfort through discreet haptic feedback to their partner by simply pressing the volume button. Partners can provide each other with a sense of comfort by reciprocating this button press. This simple interaction allows our users to acknowledge their discomfort and express it without the concern of overreacting. Ramble further lowers the threshold to communicate by providing a social media outlet that aims to normalize conversation around walking experiences and incidents on a community scale.

Pressing the volume button has additional benefits beyond communicating unease. The button press also captures the GPS coordinates of the location where the user felt uneasy. A rapid multi-press can dial 911. Once answered, a system recording will provide your GPS location to the dispatcher before switching to the phone's microphone to capture live audio. Additionally, walkers can customize other escalation preferences, such as setting emergency contacts.

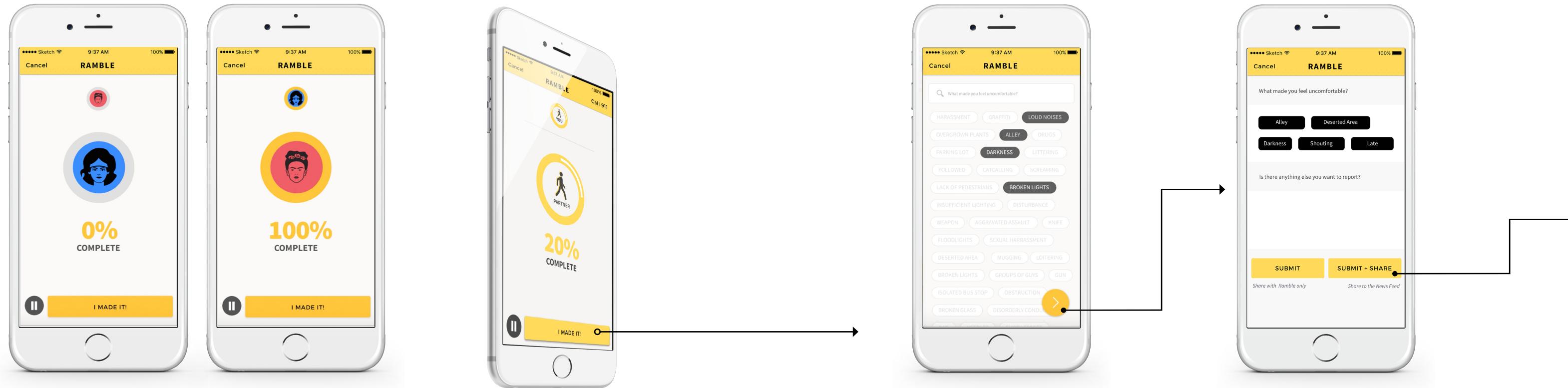


Enter Origin + Destination

When a user is ready to walk, they can navigate to the walking screen, enter their origin and destination, and then tap "Find Walking Partner" to continue. Origin and destination information are required in order to determine the length of an individual's walk so they can be paired with another walker whose journey home is of a similar duration. Additionally, Ramble calculates progress towards walkers' respective destinations to provide real-time feedback to partners.

Find Walking Partner

As a user waits to be paired with another walker, the UI displays a loading screen that features a safety tip. Presenting a user with a safety tip before they embark on a walk is an effort to increase a user's awareness of their surroundings. Participants who tested the Ramble prototype preferred having a passive safety tip before they began their walk over having the partner sending a tip or not having a tip at all.



Walk / Monitor Partner's Walk

Walkers can monitor each other's progress by viewing the progress indicator. It is important to note that although walkers can view one another's progress, they do not know their partner's geographic location and the progress indicator is a simple circular loading graphic. This progress indicator underwent several iterations with the goal of becoming less realistic and less visually interesting as the original graphic was something concept evaluation and usability participants were distracted by.

Although walkers can view each other's progress, we believe it is important for walkers to avoid attending to their device screen because attending to a device screen prevents individuals from being mindful of their surroundings, which may increase the susceptibility of becoming a crime victim (USA Today, 2012). We intentionally designed these screens to contain as little information as possible in an effort to dissuade users from staring at their cell phone. A walker can indicate that she has arrived at her end destination by clicking the "I Made It!" button.

Share Feelings of Unease

Users are able to share feelings of unease with their partner by pressing the volume buttons during the walk. A rapid multi-press initiates a 911 voice call and shares your GPS location with the dispatcher. Walkers can also customize other escalation preferences.

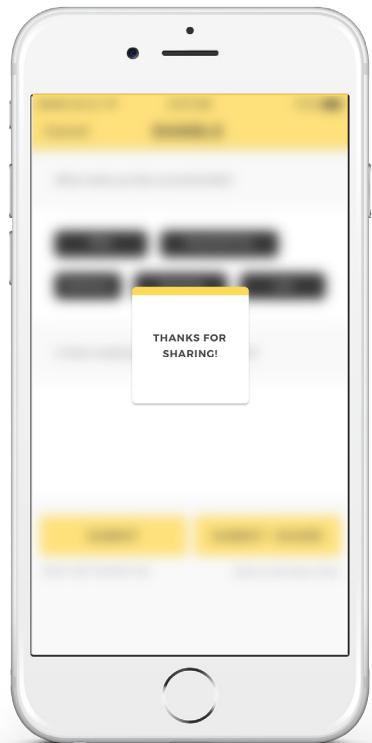
Share Experience

If the user signaled feeling uneasy during the walk, Ramble will prompt them to share more details about the source of said unease. Users are tasked with selecting relevant tags from a collection, giving users language about describing the environment they were uneasy in. Tags are "smartly" populated, that is, selecting a particular tag causes other related tags to appear. For example, selecting a tag labeled "darkness" would cause a tag labeled "broken streetlights" to appear.

Comment on Experience

If a user feels compelled to do so, Ramble allows them to provide written comments about the source of their unease during a particular walk. Users can choose to submit the experience to all users in the vicinity, or just to Ramble for aggregation purposes.

Social Media Channel



Share

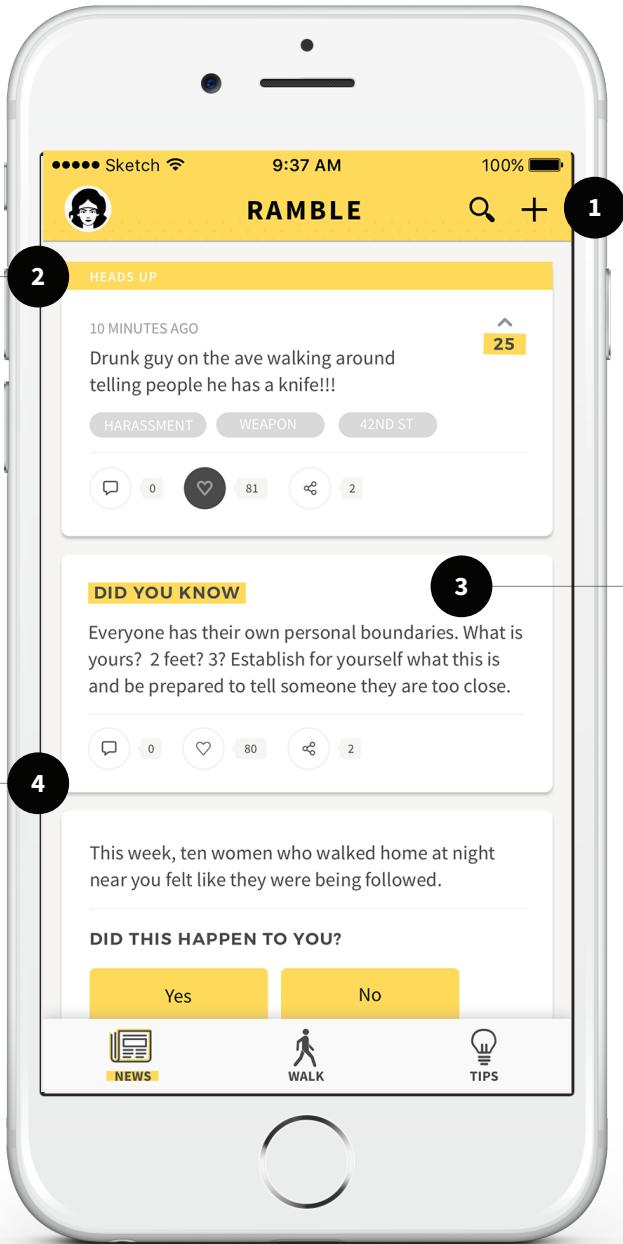
This information is then used to determine areas that could be improved through environmental design.

In addition to sharing aggregated user reports, Ramble also encourages users to share their walking experiences with others in the nearby vicinity via a social media channel. This social media channel helps normalize discussions around the threats that women face while walking alone, as well as provide information that could help other users make more informed decisions and become aware of potentially dangerous situations in the area. Our concept prototype evaluation revealed that participants do not necessarily want conversational “social” content and were concerned about the potential negative impact of having a stream of horrendous events. We decided to shape the content of the news feed so that it includes both user generated content and system generated content that strikes a tone that is more actionable and informative.

User generated content takes the form of a so-called “heads up” to other walkers in the area, as opposed to a forum for venting frustrations.

We imagine that these warnings would be time-dependent and location-dependent actionable information. This framework also mitigates the embarrassment felt for feeling afraid by prompting in a way that explains that by sharing your experience or uneasiness, you can be helping someone else directly in your area. This can also be empowering as our users’ experiences could be validated by, or overlap, with each others’.

In addition to user generated content, the news feed would also include system generated content. This content would take the form of safety tips and interactive questions and polls. This provides information that is still actionable, but not inherently time-dependent or location-based, and can be a bit more generalized. Our research participants were very keen on this type of content, and we believe that by surfacing a combination of relevant local information and conversation, as well as educational content, we are creating the right tone to provide value.



"Heads Up"

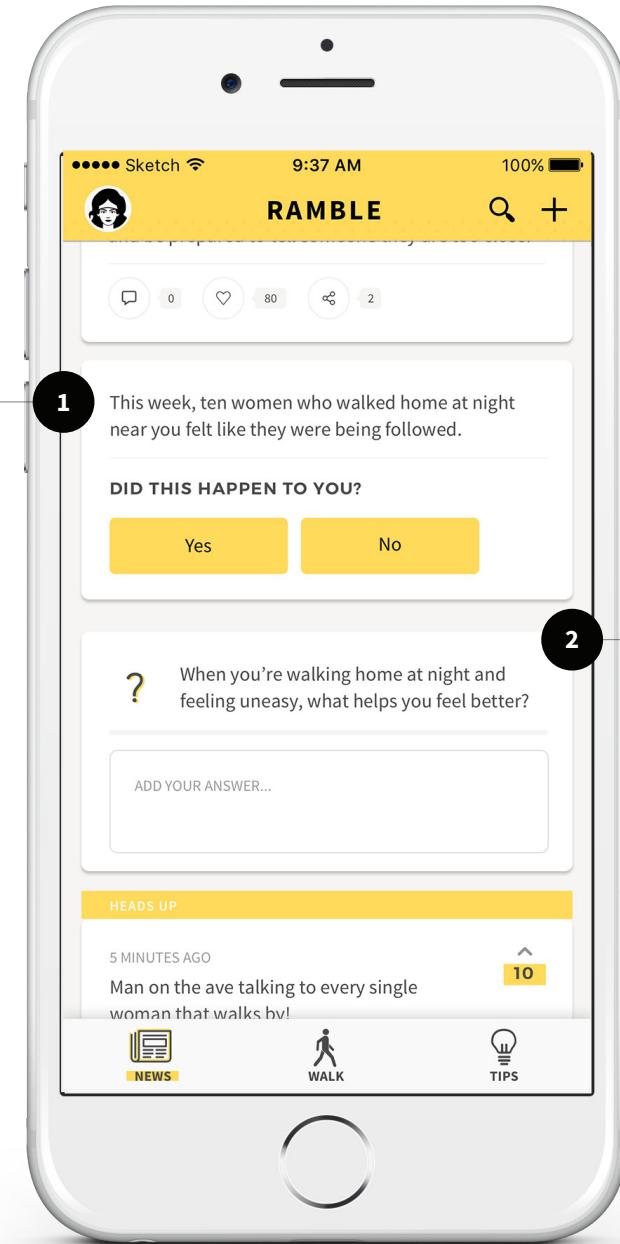
User-generated content appears on the news feed as a "Heads Up" post, alerting other users of nearby concerns. This format encourages users to only share information that can be seen as actionable, empowering other users to make more informed choices.

User Engagement

Users are allowed to upvote, comment, bookmark, or share posts.

Add

Allow users to share information directly to the news feed.



Polls

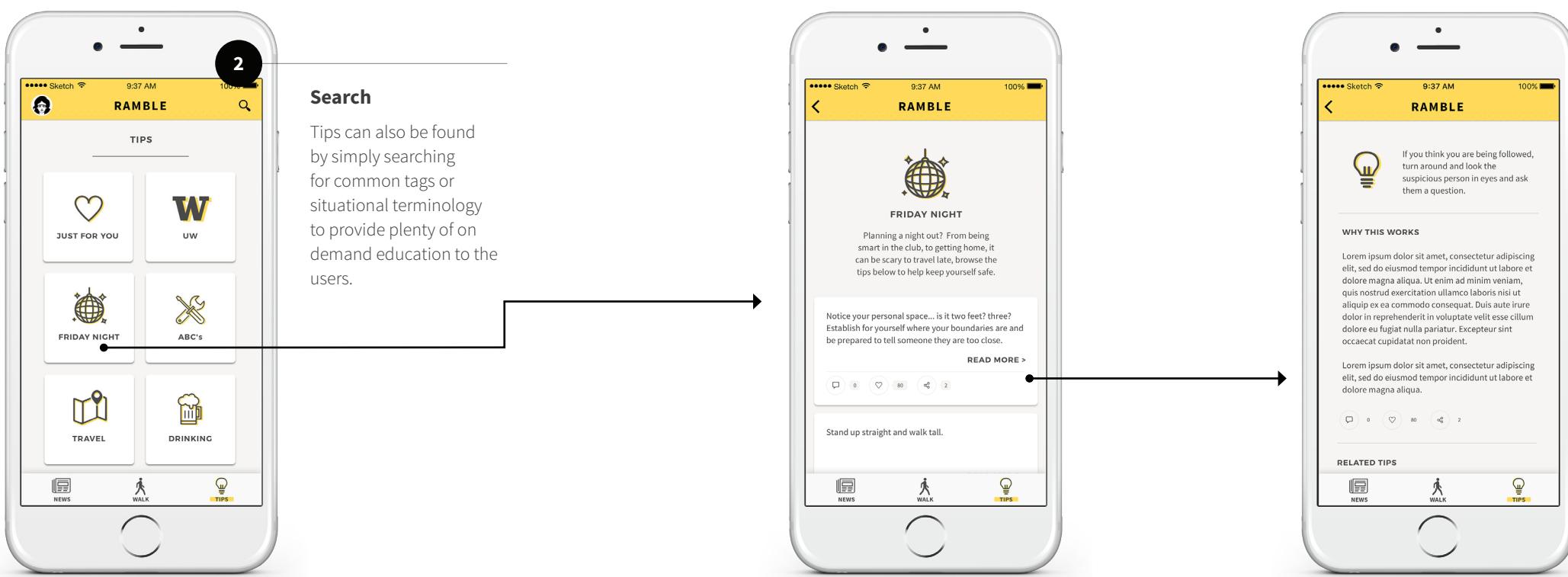
Polls are used to aggregate more information about user safety and personal experiences, in addition to surfacing common themes or situations occurring in your area. These also promote further engagement inside the app.

Question of the Day

Daily questions also appear on the news feed to promote and normalize conversation about personal safety and walking experiences.

Tips

Our primary research surfaced that participants were not confident in their ability to effectively assess or respond to risks. As previously described, we met with a martial arts and self defense instructor, Gailyn Perrin, to understand what knowledge is crucial to walking safety, which parts of her curriculum resonate well with students, and what types of information can be transferred well through an app. Our education approach manifests itself in the form of Safety Tips, which are brief, casual and relatable tidbits grounded in research. These tips promote awareness of one's surroundings, the importance of paying attention to intuition, how to carry oneself in order to reduce the chances of being targeted, and ways to respond to assailants. As recommended by Gailyn, these tips are written to be memorable and simple to understand and execute.



Tip Collections

Tips can be found in curated collections to surface similar information based on common themes. For example, the "Just For You" collection is a combination of tips that a user has favorited and ones that are recommended based on preference information.

Category or Collection Page

Selecting a collection brings the user to a list of related tips. The collection page provides a brief description of the context that these tips are useful.

Selecting 'read more' on one of the visible tips brings the user to the Tip page.

Tip Detail Page

The tip detail page explains how and why this tip works, providing more background context and credible documentation.

Sources

Gallup. (2015). In U.S., Women, Poor, Urbanites Most Fearful of Walking Alone. Retrieved April 28, 2016, from <http://www.gallup.com/poll/186563/women-poor-urbanites-fearful-walking-alone.aspx>

Hong, J., & Chen, C. (2014). The role of the built environment on perceived safety from crime and walking: examining direct and indirect impacts. *Transportation*, 41(6), 1171-1185.

Koskela, H., & Pain, R. (2000). Revisiting fear and place: women's fear of attack and the built environment. *Geoforum*, 31(2), 269-280.

Loukaitou-Sideris, A. (2006). Is it safe to walk? Neighborhood safety and security considerations and their effects on walking. *Journal of Planning Literature*, 20(3), 219-232.

Pryor, D. W., & Hughes, M. R. (2013). Fear of rape among college women: A social psychological analysis. *Violence and victims*, 28(3), 443-465.

Rosner, D. K., Saegusa, H., Friedland, J., & Chambliss, A. (2015). Walking by Drawing. In Proc. of CHI, 397-406.

Ruijsbroek, A., Droomers, M., Groenewegen, P. P., Hardyns, W., & Stronks, K. (2015). Social safety, self-rated general health and physical activity: changes in area crime, area safety feelings and the role of social cohesion. *Health & place*, 31, 39-45.

Saelens, B. E., Sallis, J. F., & Frank, L. D. (2003). Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures. *Annals of behavioral medicine*, 25(2), 80-91.

APPENDIX

Links to Appendix Materials

A. Subject Matter Expert Interview Protocols

https://docs.google.com/a/uw.edu/document/d/1RYHwUi8l5fODDghHZEO_9Fm-8aibHDbz1jcA2iQExyU/edit?usp=sharing

https://docs.google.com/a/uw.edu/document/d/1ePJd66JUvZI-EVCLDU-E7nNG879_1KMYUfDu-1We7uU/edit?usp=sharing

https://docs.google.com/a/uw.edu/document/d/1-12woYefkKVhDQFQGA0yG1vo7cnmhukAL_c7sKX6Cec/edit?usp=sharing

<https://docs.google.com/a/uw.edu/document/d/18OFGVGJ6lpeJbLnEV6RwnPM5PWiEYnnQVWycRuayhtE/edit?usp=sharing>

<https://docs.google.com/a/uw.edu/document/d/1vKewbLsOsG1mrSvFkyCpT1v10hqlB6vUUBpdXqQWwbE/edit?usp=sharing>

B. Diary Study Protocols

https://docs.google.com/document/d/1-1U_ll0dpLDUBax1hTrddN4EyaCEaP7YQxKcX1vmwZ4/edit?usp=sharing

<https://docs.google.com/a/uw.edu/document/d/1Dly8bOMXu5leq7sL4dMIQ8ReXSbNm6uQPA8if4l1Yo/edit?usp=sharing>

https://docs.google.com/document/d/1GMSVYTce_GzO7L_xl16bAU0NM5lYRomatTOIIxxWOfg/edit

<https://drive.google.com/a/uw.edu/file/d/0B8taLH2QJAw4eXIDbHBpRGpxeXc/view?usp=sharing>

C. Field Research Guide

https://docs.google.com/document/d/1BB3oCuCQkYhTsVsLaqHdZt_yND2j8QxwQ5JUqXpOGdI/edit?usp=sharing

D. Semi-Structured Interview Guide

<https://docs.google.com/document/d/1FlkqTMtlAlTV-ltNCOKeDeMjlq7nu-0SdMAESXm7xw/edit?usp=sharing>

E. Prototype Evaluation Testing Guide

https://docs.google.com/document/d/1Yr_S1lOo3GTyPYcbWO5FsWmcN4hOR1YXfQSOVNUTKBI/edit

F. Usability Test Guide

https://docs.google.com/document/d/19QTsGfqkTScr7Pqlq6Y34ZqoCo3FiPVhn4jr_uwFh3s/edit?usp=sharing

G. Competitive Analysis

<https://docs.google.com/a/uw.edu/document/d/1zxo3Dm3PjU7s5Td5182N3Me8Rxnd8OCSoxlH7d-Ey68/edit?usp=sharing>