California Polytechnic State University
Graphic Communication Department
GRC 429: Mobile User Experience Winter 2020
Professor Bruno Ribeiro

AR Training

Fire simulation AR goggles for training

Josie Grundler
Jessica May
Paul Rogers

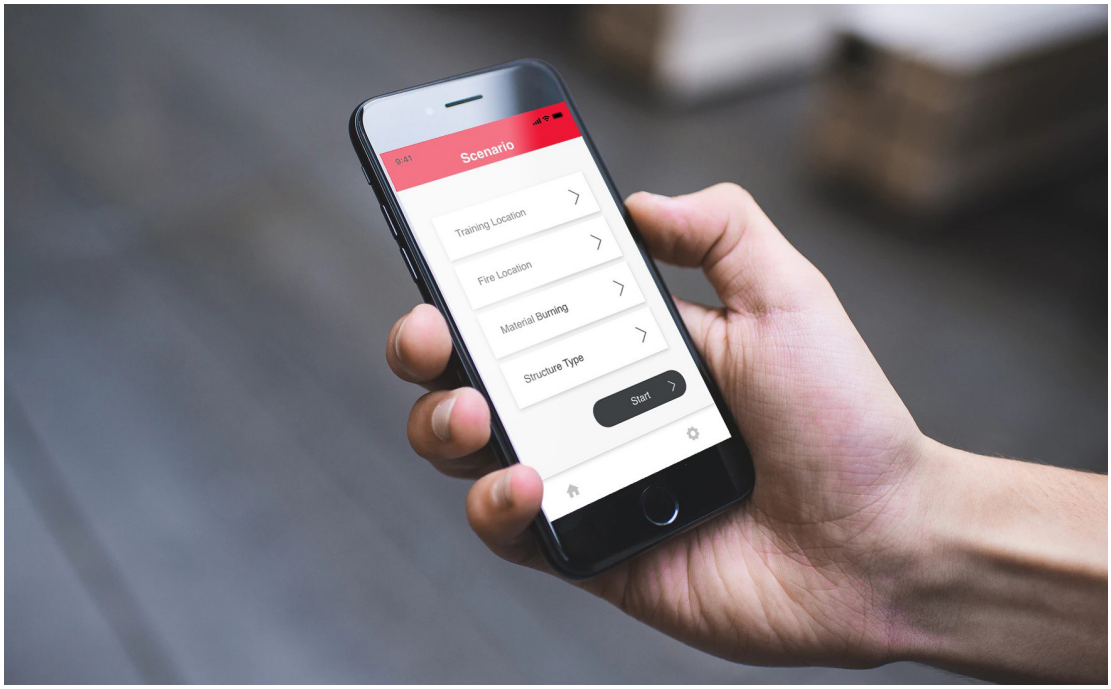
8 March 2020

Table of contents

Introduction

Abstract

Firelens AR goggles are designed to improve the training practices of firefighters, specifically by accurately simulating the intensity of victim structure rescues. By implementing augmented reality, Firelens will give the user the ability to train for a wide variety of high hazard, low frequency emergencies that would otherwise be nearly impossible to train for. Using the same physical structure, these goggles allow the user to navigate through different scenarios with varying risks, structure materials, structure ages, causes of fire, and number of victims. No two scenarios will be the same, significantly increasing the users readiness for real emergency calls. Firelens improves quality and quantity of training, thereby keeping both firefighters and the environment safe.



Schedule

Week 1: 1/6–1/10
Pick groups, choose potential domains, audience justification

Wednesday 10am–12pm: Group meeting

Week 2: 1/13–1/17
Report update: Cover, table of contents, schedule, audience, research questions, competitive landscape

Wednesday 10am–12pm: Group meeting to brainstorm product ideas

Week 3: 1/21–1/24
Tuesday 1/21 10am: Interview firefighters

Wednesday 10am–12pm: Group meeting to pdate product ideas and start sketches

Week 4: 1/26–1/31
Report update: Abstract (tentative), summary of the answers, persona, goals

Wednesday 10am–12pm: Group meeting

Week 5: 2/3–2/7
Report update: Scenario, interaction framework

Wednesday 10am–12pm: Group meeting

Week 6: 2/10–2/14
Report update: Wireframes, usability analysis tests

Wednesday 10am–12pm: Group meeting

Week 7: 2/17–2/21
Report update: Usability analysis results, updated wireframes (changes from the results of usability analysis)

Wednesday 10am–12pm: Group meeting

Week 8: 2/24–2/28
Report update: High-definition layouts

Wednesday 10am–12pm: Group meeting

Week 9: 3/2–3/6
Report update: Design principles analysis, technical requirements, possible constraints, final product, ethical considerations, future enhancements, all else

Wednesday 10am–12pm: Group meeting

Week 10: 3/9–3/13
Report update: Final report

Wednesday 10am–12pm: Group meeting

Audience

As first responders, firefighters rush in to combat fires, deal with hazardous materials, help with search and rescue, and more. The job is strenuous and dangerous, and AR could be used to help keep firefighters safe. Using modern technology to enhance training would decrease the number of skills firefighters would have to learn on the job, helping them do their work more safely and effectively. Furthermore, enhanced training might be able to speed up the process, which will be useful if turnover rates for fire departments worsen.

Technical requirements

Our app is relying on goggles with augmented reality capabilities to create a more engaging and accurately simulated house fire. The goggles must clearly display digital content on top of the real world to improve their training process and enhance the experience, while the app must provide an easy way to customize the training scenario and upload it to the goggles.

Possible constraints

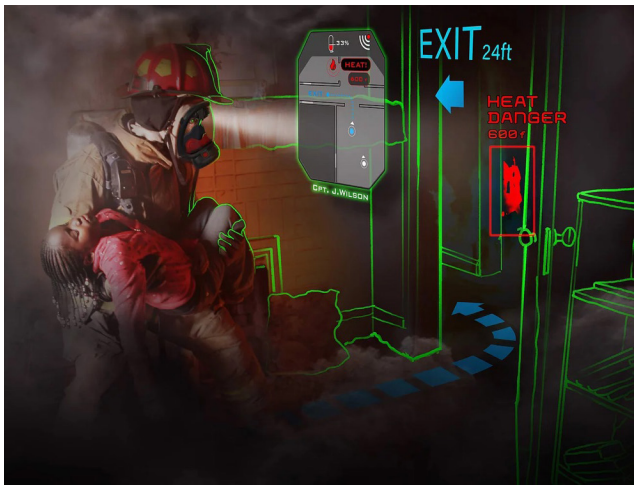
Possible constraints with the application include limitations in how realistic the fires will be, limited ability to record date, and how many total possible scenarios can be created compared to the number of scenarios that can occur in real life.

Competitive landscape

Existing alternatives

C-THRU - Qwake Tech (https://www.qwake.tech/)

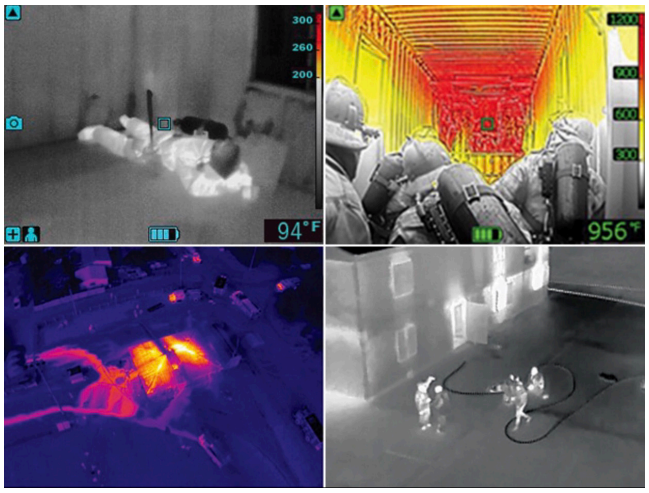
Qwake Technologies designed a helmet to help firefighters navigate through terrain with poor visibility. These helmets provide the user with vital information about the surrounding environment to guide them through dangerous, situations. This helmet uses cameras and sensors to augment a firefighter's vision so they can remain focused on the job while still getting support from command in their line of sight.



The cameras and sensors used on the helmet provide the firefighter with edge detection, object recognition and hotspot identification while transmitting fire event recordings and live streaming to a command station.

FLIR (https://www.flir.com/instruments/firefighting/)

FLIR designed a handheld thermal imaging camera that helps firefighters see fires movement through smoke filled rooms. This requires the user to have a free hand and to momentarily take their eyes off of the environment to direct their attention at a small screen displaying the information.

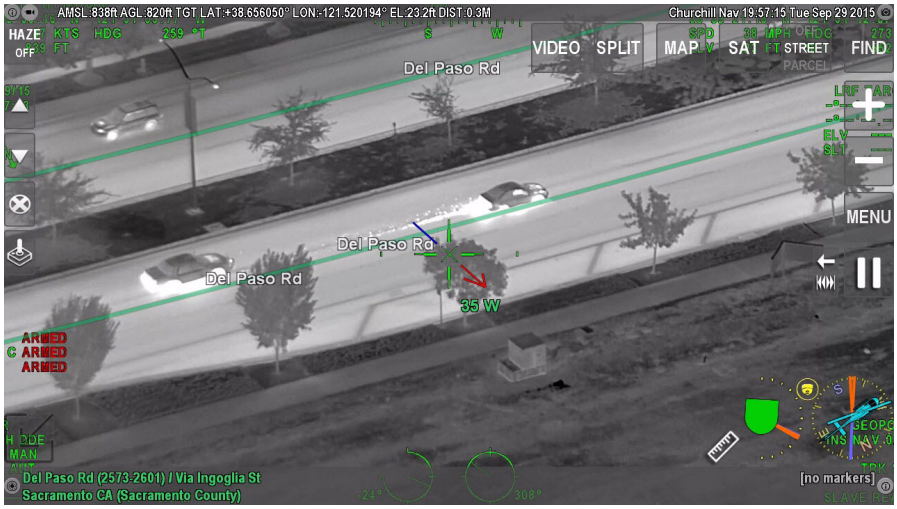


This device helps the user visualize their plan of attack by proving hotspot locations and nearby objects. This device can be used with other cameras and drones to see every angle of the situation.

Similar form factors

LLVision Technology

LLVision Technology has designed a headset to provide police and public security officers in China with facial recognition software to improve security and identify high profile suspects in milliseconds.



In airborne law enforcement they have used augmented reality to display street names, intersections, direction of travel and speed during a pursuit by helicopter or drone.

Visual language references

Fire truck / Fire engine

Protective ensemble

Fire station

Fire hose/pipe/line

Firefighter helmet

Pick head axe

Research

Research questions

1 In cases of low-frequency, high-risk events that, together with other factors, what are training gaps that you see that have contributed to the line of duty death? What steps have you already taken to close those gaps?

2 What is a typical training day like for you? How often do you train?

3 What kind of problems do you run into when preparing for emergency situations?

4 What steps do you take in the fire station before you leave to mitigate on field emergency?

5 How accurately does your training simulate an emergency situation?

6 What kind of decisions do you have to make during emergency situations? Are they different during a residential fires compared to wild fires?

7 Do you have specific training for different scenarios?

8 How often do you come in contact with an emergency similar to your training?

9 What parts of training are currently only possible on-the-job?

Findings from the research

Jason
Firefighter training can include vehicle fire extractions, medical training, helicopter training, victim rescue, and hose testing. Some low-frequency, high-hazard emergencies are hard to train for. Digital simulations provide some training, but they provide limited scenarios so many situations have to be learned on the job.

Trevor
Firefighters in training have a task book with over 230. While learning the subject matter, trainees give presentations on the material to the others which both reinforces learning and refreshed the memories of the firefighters.

User interaction design

Persona

Gabriel "Gabe" Neilson

"Training for low-frequency-high-hazard situations is hard because those events don't happen often enough to learn on the job. Now that we can't burn demo houses, we need to find a way to train for modern house fires."

Gabe is a 37-year-old firefighter at San Luis Obispo's Fire Station #2. Due to his recent promotion to Lieutenant, he is now responsible for supervising daily operations and spearheading training. He wants to modernize training to improve firefighter health and safety. However, many high hazard, low frequency situations are too difficult to learn on the job and there are limited alternatives for training.

Goals

» Increase firefighter health and safety

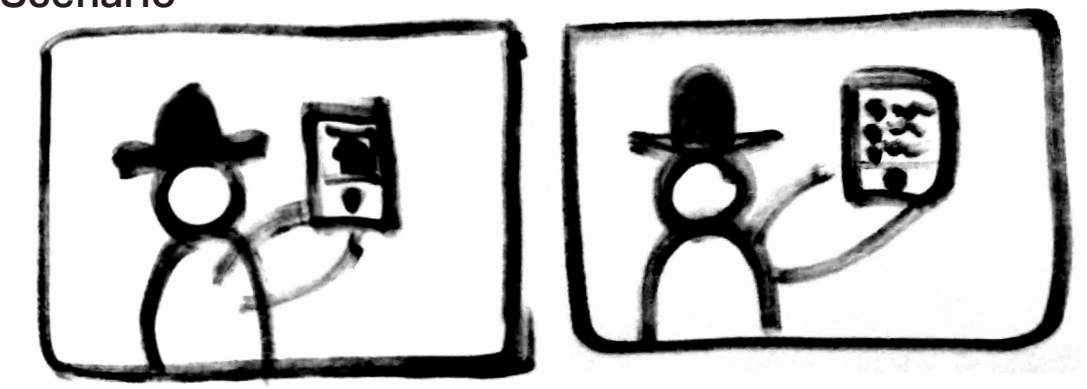
» Training for low frequency, high hazards situations

» Adapting to fires of modern homes

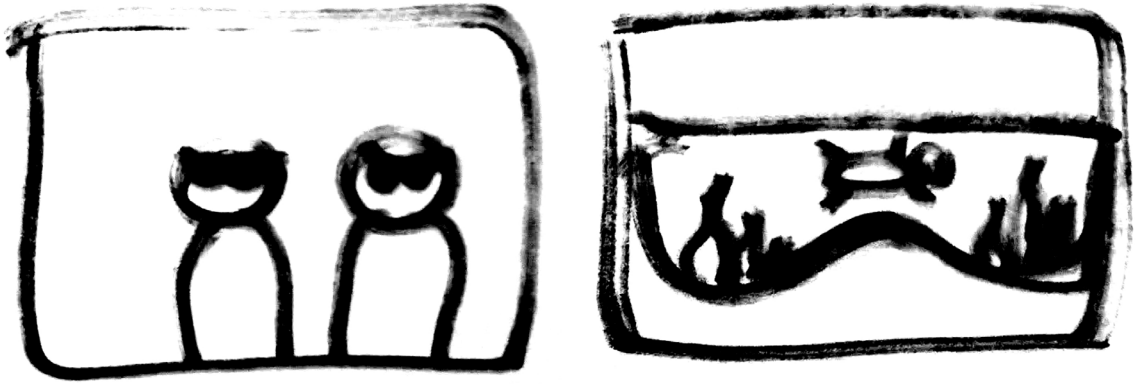
» Training without exhausting finite resources

» Train while minimizing environmental impact

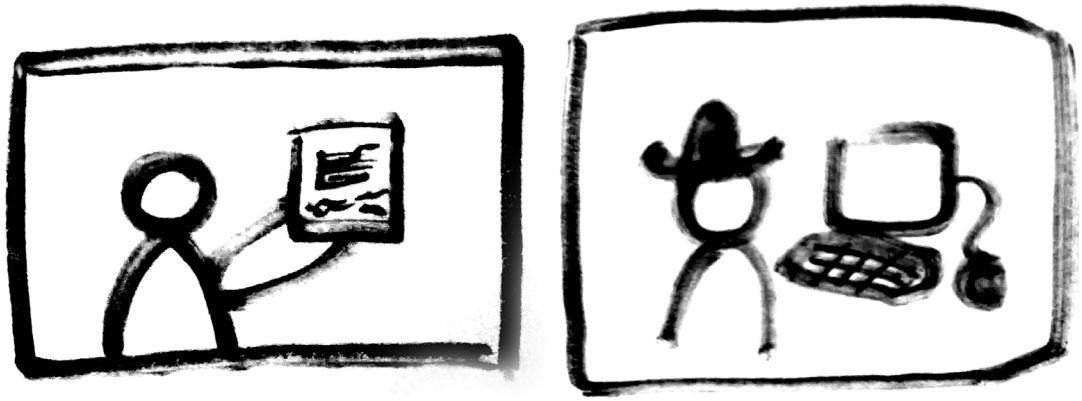
Scenario



Officer Neilson sets up a structure in Firelens by inputting structure blueprints. He then creates a custom scenario where a citizen has been trapped in a burning building. He sets the cause of the fire as the kitchen, sets the structure as built in the1960's, and the framing as lumber. He loads the scenario into the goggles.

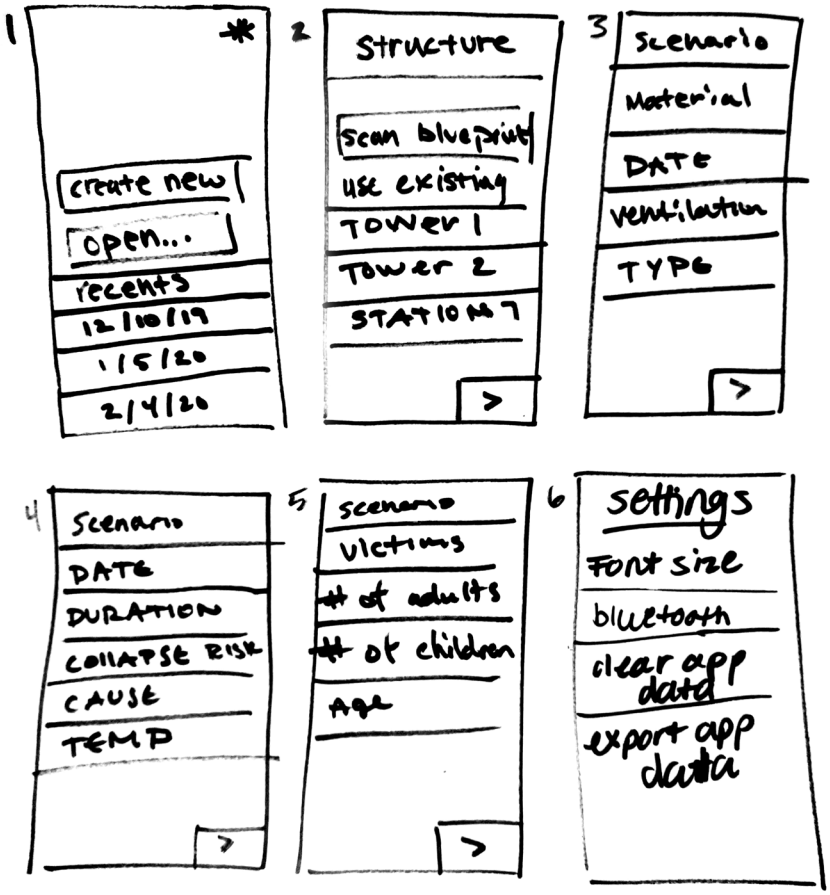


While training, firefighter Richardson and fellow trainee wear the goggles which simulate the customized fire and train to rescue the simulated victim.



When the simulation is over, Neilson gets to evaluate Richardson's performance through playback and go over errors.

Interaction framework



1. Landing page allows the user to create a new scenario or open recent scenarios.

2. After selecting “create new” the user is presented with the ability to choose between scanning a blueprint or choosing existing structures.

3. The user sets their scenario by adjusting the material- construction year, ventilation, and fire type.

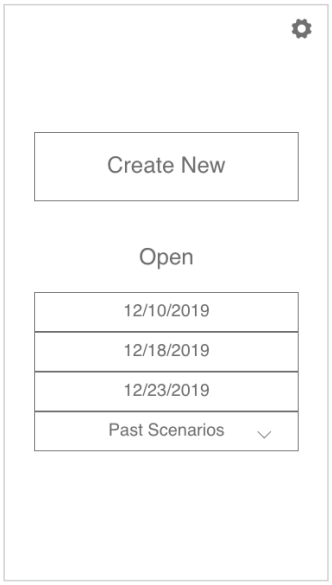
4. The user sets their scenario by adjusting the construction- duration, collapse risk, cause of fire, and temperature.

5. The user sets their scenario by adjusting the victims- number and age.

6. Settings allows the user to change the font size, add to bluetooth, clear and export app data.

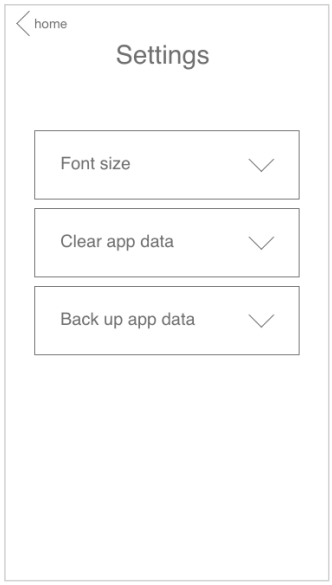
Wireframes

Splash screen

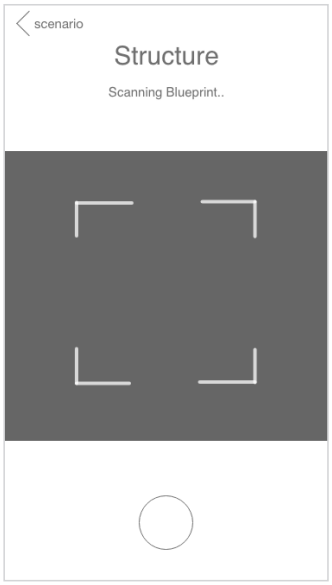


Home page

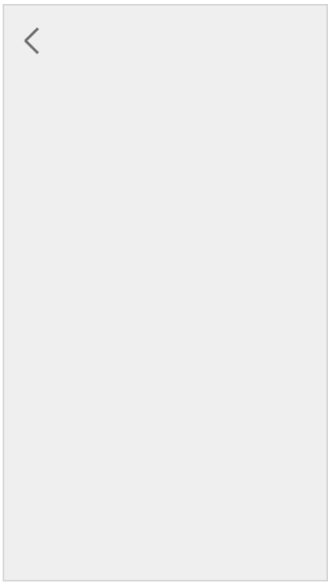
View past scenarios



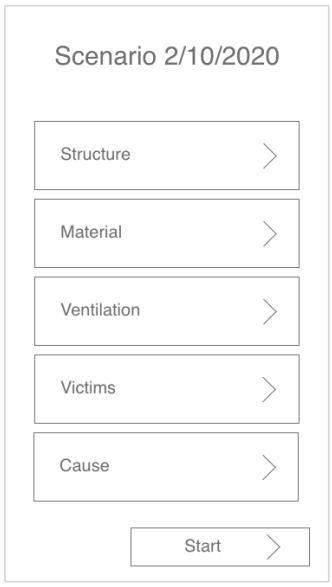
Settings



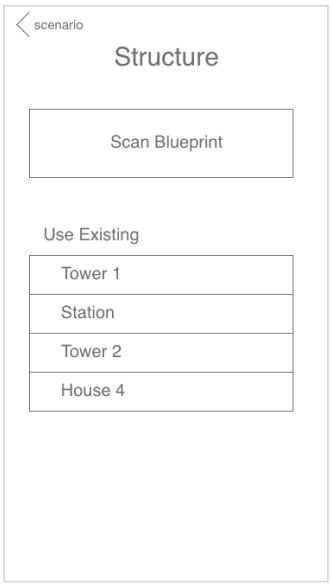
Scan blueprint



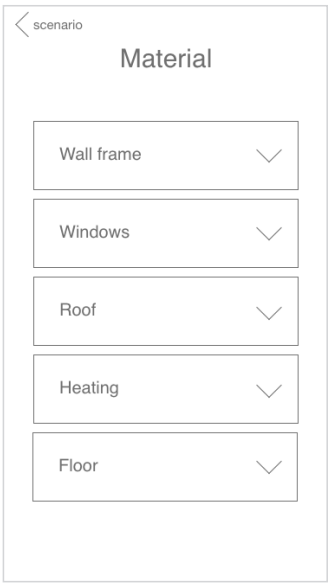
Simulation page for officer to follow along an active scenario.



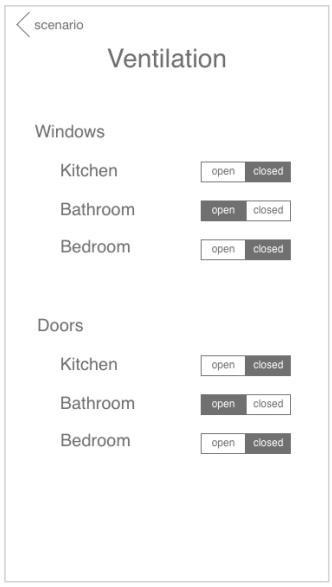
New scenario



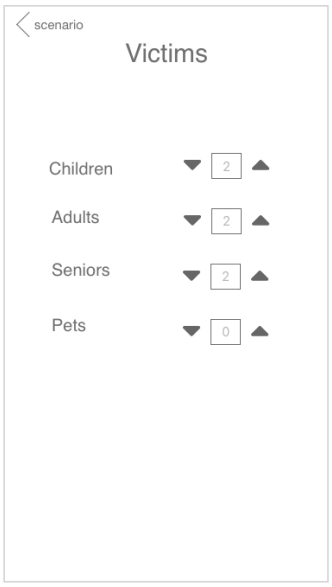
Structure layout



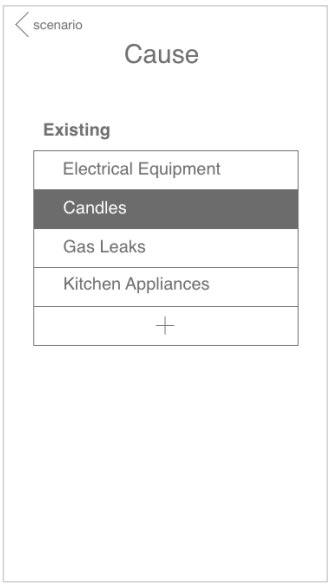
Materials of structure's parts



Ventilation



Victims in the building



Cause of fire

Usability analysis

Usability analysis tests

This wireframe demonstrates the functionality for the app that would allow firefighters to set up scenarios which train firefighters in victim rescue and strategy for putting out different types of structure fires. Each scenario is customizable to allow the training officer to change the structure thereby creating a variety of circumstances and providing a diversity of situations to train for.

While creating a new scenario, the user can choose the following elements to customize: The layout of the structure, building material of the structure, ventilation in the structure, victims in the building, and the cause of the fire.

Task 1: Create a new scenario.
We asked the user to create and customize a scenario. This task entails defining the scenario by choosing a structure, building material, ventilation, victims in the building, and cause of the fire.

Task 2: View a past scenario.
We asked the user to review a previously executed scenario. This task entails reviewing the list of previous scenarios and examining the corresponding data.

Task 3: View a simulation.
We asked the user to watch an ongoing simulation. This task entails opening and watching a scenario as it is being executed by trainees.

Usability analysis results

We tested our wireframe on three firefighters. First they told us about SimsUShare, software which allows users training for emergencies to upload photos and insert simulated emergencies. Then, they told us about HaptX, which is developing VR for a variety of training, including pump operation for firefighters.

While clicking through the wireframe, the firefighters provided more feedback on the content than the layout or functionality of the wireframe. They told us that some of the customizable elements we included in our wireframe don't make enough of a difference in fighting fires to be worth including in training.

One firefighter recommended focusing on the location of the fire (kitchen, bedroom, etc.) and what's burning (natural gas, contents of the structure vs. the structure itself). Another firefighter suggested that knowing the structure type helps set expectations when arriving on scene, so an option to choose single family residential, multi family residential or commercial would be helpful.

Furthermore, in addition to information about the fire being dispatched while firefighters arrive on scene, a 360° or walkaround is performed to assess how to fight the fire. This section was added to the scenario summary.

The firefighters didn't comment much on the user interface, but were visibly struggling to toggle between pages. To fix this issue, we increased the size of our back button, and made the layout more intuitive by updating the wireframe's content based on their feedback.

Changes from the results of usability analysis

To address the difficulty in pressing back buttons, instead of having just the words next to the arrows link back, we added an invisible box around both the arrow and its label to increase the area of the back buttons.

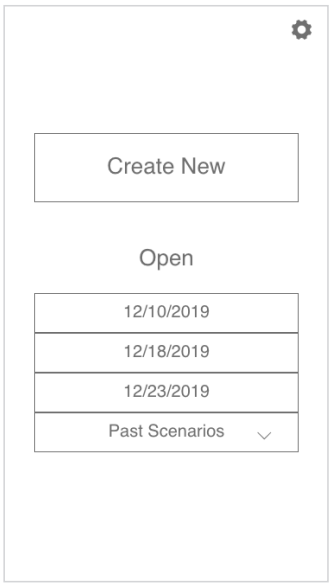
The firefighters heavily critiqued the content of the wireframes, so we made changes according to all of their feedback.

We updated the sections of the scenario building that are customizable to match what the firefighters expressed was the most important. We got rid of the "Material," "Ventilation," "Victims," and "Cause of Fire" pages and instead created new pages for "Location of Fire," "Material Burning," and "Structure Type."

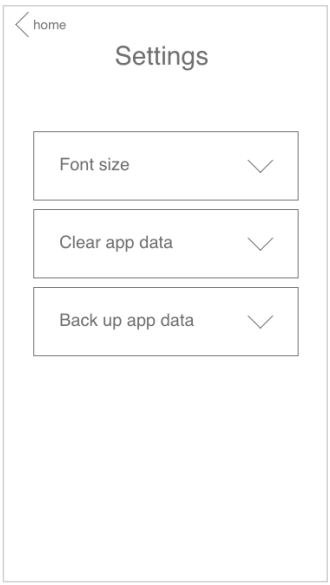
The "Location of Fire" page allows the user to customize where in the structure the fire is happening. The "Material Burning" page allows the user to customize whether the fire is burning the structure itself, just the contents of the structure, natural gas, etc. Finally, the "Structure Type" page allows the user to choose whether the structure is a Single Family Residence, Multi-family residence, or Commercial structure.

Additionally, we realized throughout testing that we needed to show an example of what a user could view when revisiting past scenarios. We created the "Scenario 11/23/2019" page and incorporated a "360°" section which would include information gleaned from performing a walk-around.

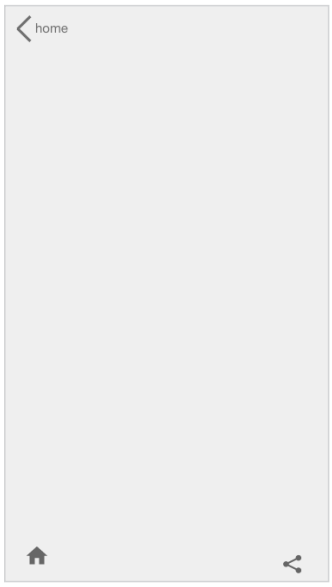
Splash Screen



Home

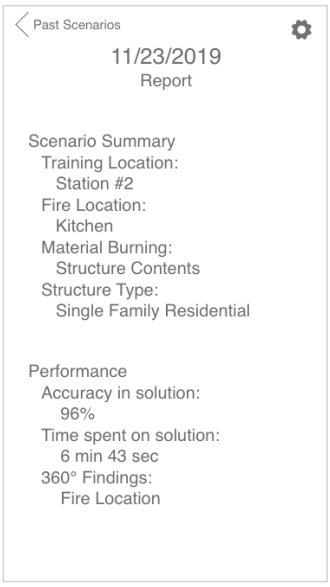


Settings

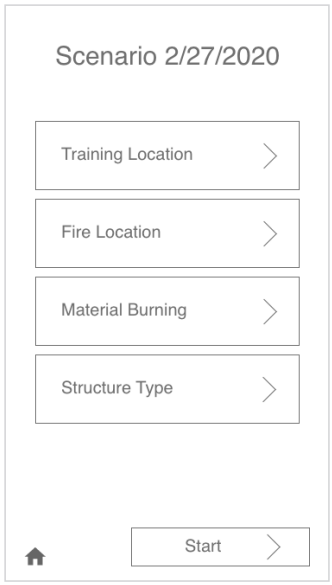


View Simulation

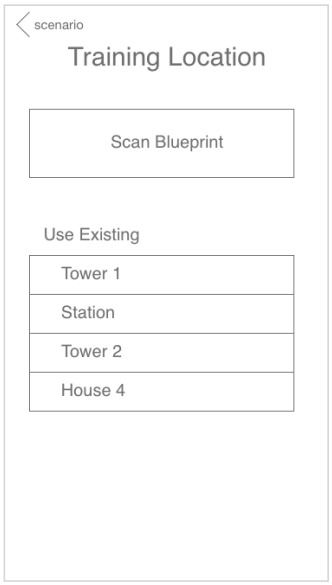
Past Scenarios



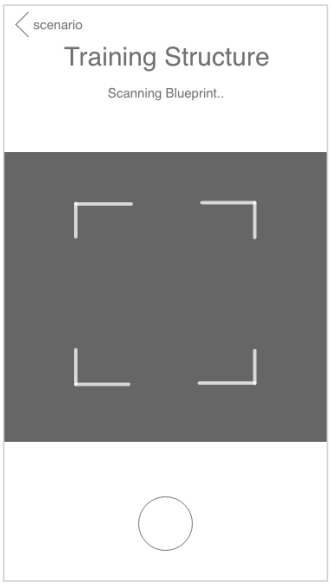
Summary of a previously executed scenario



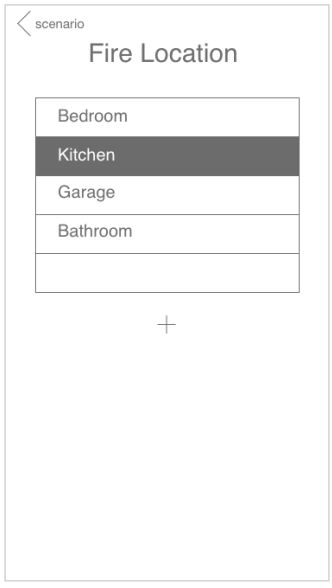
Creating and customizing a new scenario



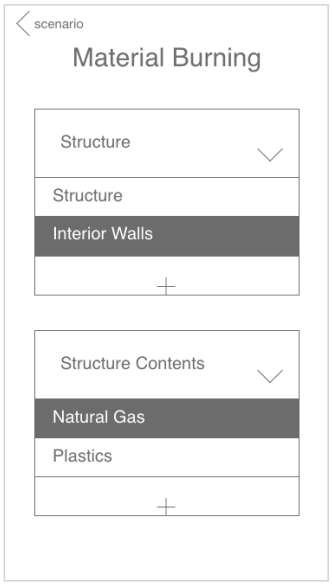
Building in which the firefighters will be training



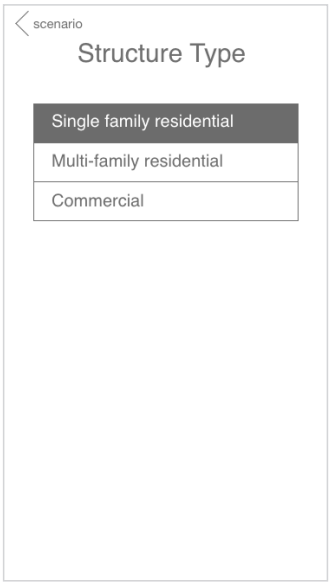
Scanning blueprint for a different training building



Location of fire within structire



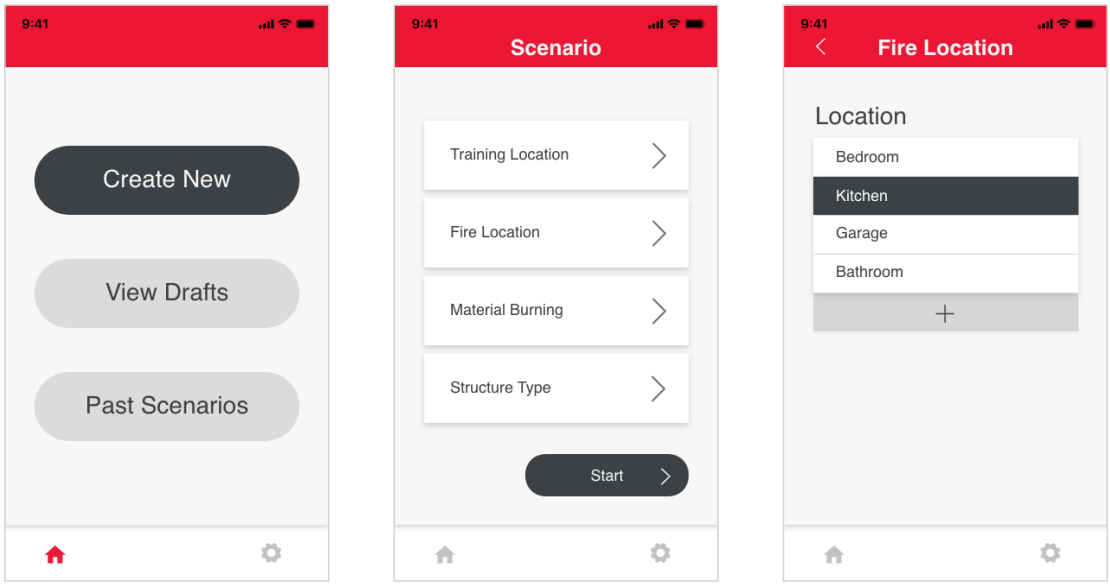
What is burning in the structure fire



Which type of structure is being burned

User interface design

Annotated layouts

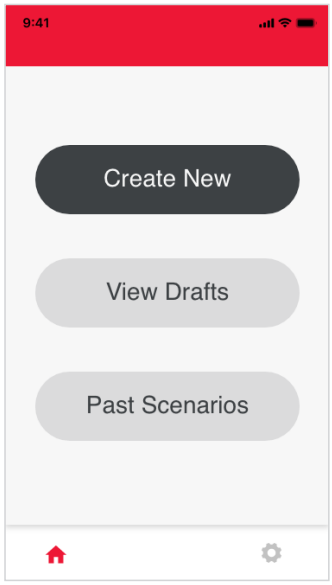


We modeled the general aesthetic of our high-definition layouts after other firefighter apps by using a fairly neutral color palette with red to add a pop of color. We chose the red color that is strongly associated with firefighters and firetrucks. Beyond the red and neutral color palette, we wanted the design to be simple in order to maximize functionality and legibility.

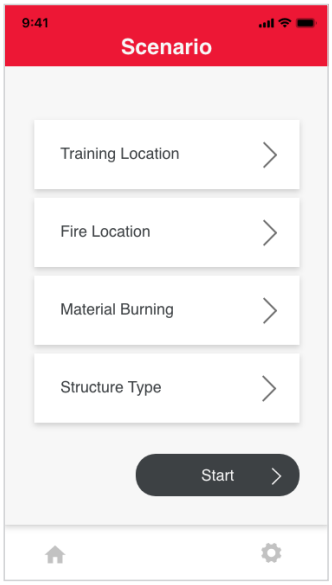
The buttons were made round and fairly large to increase the target size to make them easier to select and also for consistency all all action buttons were rounded. Additionally, the dark grey color is used to draw the user's attention for actions. For example, "Create New" is dark to attract the user, and "Kitchen" is the same color to show the users that they performed a task by selecting that option. All icons used were the standard iOS icons to increase consistency and usability.

We chose the Airbnb Cereal typeface because it's rounded but sharp, so it fits the visual language of the app and enhances legibility. The weight of the type was chosen to ensure that all text would be easily readable and legible, and complement the tasks the user needs to complete without distracting the user.

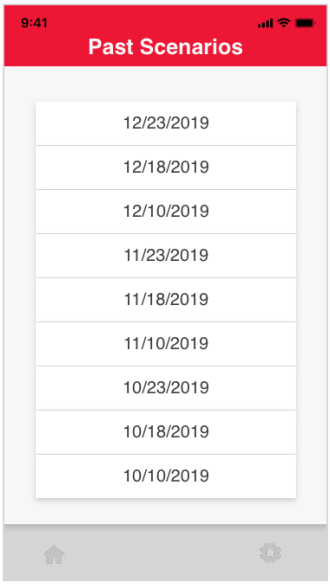
Final product



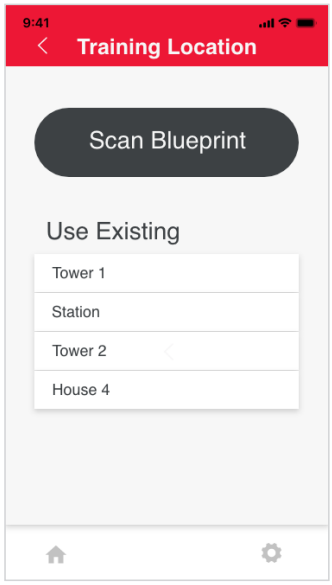
Users can create a new scenario, view drafts, and view past scenarios.



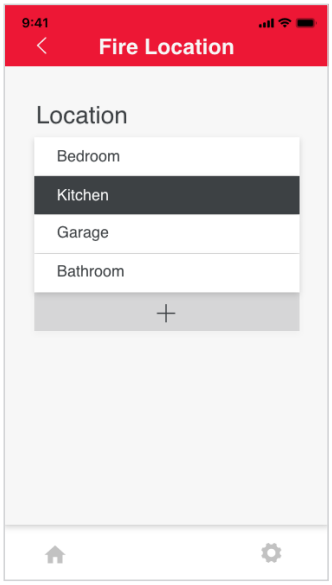
Users can customize scenarios in these four areas.



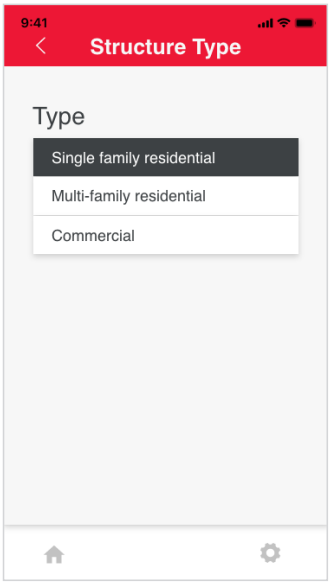
Firefighters can view previously completely scenarios.



Users choose the training location from a list or by scanning a new blueprint.



The user customizes the location of the fire.



The user chooses what type of building contains the fire.

Design principles analysis

Flexibility-usabilty tradeoff

As the flexibility of a design increases, the usability and performance of the design decreases. As the simplicity of our design increases, the usability and performance of the design makes it easier to navigate. With its narrow focus, the user should be able to focus on its simple task of creating a training simulation.

Consistency

To improve the usability of the interface, a consistent set of fonts, colors, and buttons are used across the layout. When creating a new scenario, each submenu used for customization has a similar appearance for menus. Buttons whose actions take you to a new page are rounded, and menus with selection options are rectangular and the selected option becomes darker.

Mental Model

A common mental model for mobile application includes a small gear to represent the settings page and a small house button to go to the home page, as well as navigation bars that are accessible throughout the interface. To adhere to a new user's mental model of mobile applications, we included those standard home and settings buttons in a navigation bar located at the bottom of nearly every screen.

Performance load

In order to minimize the performance load, our app minimized the total number of screens and actions needed to accomplish the user's goal. By understanding the users context we were able to limit the amount of text and elements on each page to reduce the time it takes to complete the set up and begin the training.

Wayfinding

To improve navigation through our mobile application, we included a title at the top of every screen to help a user assess their current location within the app, buttons are clearly labeled to help a user determine their route, and a navigation bar is almost always at the bottom of the screen to help a user return home at any time.

Hick's law

We limited the number of options provided on the home, settings and scenario pages to decrease the time a user needs to make a decision and complete the training. This helps direct the users attention and encourages them to proceed in setting up their training session.

Chunking
To improve the user's ability to comprehend the information on each page, we grouped the information into various sections. There are separate pages for the user to create a new scenario versus viewing past scenarios. While creating a new scenario, the four areas of customization each get their own page: Training location, fire location, material burning, and structure type. When viewing the past scenarios, the user only views data for one scenario at a time and the data is divided into sections.

Similarity
Related elements within our interface were designed to look the same or similar in order to improve the perception of their relation. For example, the four sections of customization when creating a new scenario are all identical buttons, but they are a different style of button than the "Create New" and "start" buttons.

Proximity
In order to show the relationship between different options of the submenus, we put related items close to each other.

Alignment
In order to show the hierarchy of information on each screen, we aligned each element with features of identical importance. For example, the title of each screen is centered at the top of every page.

Fitts's law
We made the size of our targets as large as possible to improve usability. For example, we made interactive buttons like the back buttons larger. We also made the start button fairly large and close to the other buttons so that it would be easy to click once settings are finalized.

Visibility
By optimizing and refining the content placed on each page we can lead the user though the process and guide them through a series of steps. We only included the necessary information on the landing and home page to make the app accessible and easy to navigate.

Recognition over recall
All of our menus have lists that the user can choose from so that they simply have to recognize the features they want to customize rather than recall them. Furthermore, the "Past Scenarios" page provides a list so that the user can recognize the scenario they want to view instead of recalling the exact date of that scenario.

Picture superiority effect
The picture superiority effect doesn't really apply to our interface as there are no photographs in the interface itself.

Serial position effect
Things presented at the beginning and end of a sequence are more memorable than things presented in the middle, which is why our "Create New" button appears at the top of our home page and the "Past Scenarios" button appears at the bottom.

Signal-to-noise ratio
In order to optimize the signal-to-noise ratio, we included very little to no extraneous information anywhere within our app, and users looking for more information can look for it when they want it rather than be bombarded with information they don't need.

Accessibility
To optimize the accessibility of our interface, the colors used to convey information are high contrast and easy to read, the typeface is simple, and all text is easy to read.

Control
The level of user control should be related to the proficiency and experience of the user. The app is designed to be used by firefighters; they have the expertise knowledge and experience of what each section means: Training Location, Fire Location, Material Burning, and Structure Type.

Errors
To help the user avoid errors, we included back and cancel buttons throughout the interface. We also added a confirmation box when the user clicks the "start" button to start the simulation, as they can no longer alter the simulation when the trainees are doing the scenario.

Forgiveness
In order to ensure that the user is not heavily punished when an error is committed, our design allows some actions to be reversible. For example, there is an option to delete scenarios that were made accidentally. Furthermore, at any point, a user may exit the app or go to the home page, and the scenario will be saved as a draft.

Feedback
Options are darkened to give user feedback when they select them. The interactions are placed on each page to allow the user to feel engaged for a moment while selecting an option. This enhances the users experience within the app and improves the communication between the interface and the user.

Aesthetic-usability effect
Our design aesthetic looks simple and easy to use, therefore it is simple and easy to use. When problems are encountered, the design of the interface makes people more tolerant because it's aesthetically pleasing. Creating a positive emotional response to our interface is important to our design.

Expectation effect
In order to prevent any expectation effects from biasing the results of our usability testing, we made sure to use neutral language to describe our app as simple as possible to allow the firefighters to form their own opinions.

Affordance
In order to improve the usability of the interface, we designed our buttons to afford clicking but giving some of the buttons some dimension to emulate physical buttons. Additionally, our home button is a house icon, and the button for adding options is the symbol for addition, or "plus" sign.

Color
We modeled the aesthetic of our layouts after other firefighter apps by using a fairly neutral color palette with red to add a pop of color. We chose the red that is strongly associated with firefighters and firetrucks. Beyond the red and neutral color palette, we wanted the design to be simple in order to maximize functionality and legibility.

Highlighting
A technique for focusing attention on an area of text or image, we rounded the most important buttons while the rest stayed rectangular. Buttons such as "Create New" and selected buttons had reversed out text and a dark background to indicate they had been selected. We used a bold text to highlight the labels of each section.

Legibility
Since our app is used by firefighters who are out in the field daily, we needed to make sure our design was legible and easy to read. We use a minimal amount of text—used only with our buttons. We purposely picked a typeface that had high legibility and a low stroke contrast. We used a dark text on a light background for optimal legibility, avoiding patterns and textured backgrounds.

Iconic representation
Apples basic iOS icons are used in our design to improve recognition and recall, and also goes along with the mental model. The Home and Settings buttons are examples of resemblance and symbolic icons, respectively. Apple's symbols are known worldwide and share a common visual motif for optimal performance.

Ethical considerations

While the app is designed to help firefighters train for a variety of house fires, this simulation will not be perfectly accurate which puts the firefighters at risk of being over or under confident after completing the training. After excelling in multiple scenarios, this can provide the user with false confidence, leading them into a fire in the real world and showing poor results.

Future enhancements

In the future, this application has potential for greater customization in the scenarios, and the scenarios could even expand from structure fires to other emergency situations, including hazardous materials and vehicle fires.

Additionally, this product could be expanded into a virtual reality game. The use of virtual reality in place of augmented reality would allow for a significantly greater variety of scenarios, from structure layouts and types to contents of the buildings. Furthermore, the responses to the scenarios could be expanded in terms of increasing hands on experience practicing victim rescue and fire extinction.