Conceptualizing the Design and Use of Augmented Reality Within a Common Operating Picture for Incident Command Systems

Interim Report #3
April 4th, 2022

For **Indiana University Crisis Technologies Innovation Lab** and **Director of User Experience, Sonny Kirkley**

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Executive Summary

The third phase of the project began with an interview with Kirk Mackenzie. Kirk provided the team with insights into current products related to incident command and control, situational awareness, and future technology adoption. The team learned that situational awareness is the biggest challenge faced in incident command situations to date and that tracking capabilities would offload current complexities significantly.

Following this, the team conducted an interview with Chief Jacob Spence in which Spence described an emergency that he deemed particularly difficult to manage. This incident was the Civil Unrest of 2020. It was discovered that in most situations, Incident Commanders and Emergency Response Departments can execute pre-vetted plans. However, there are some incidents with additional variables that these plans simply cannot account for, and in these situations real-time data becomes even more invaluable. A few specific pain points from the Civil Unrest of 2020 included the rapidly changing situational data, and contradictory verbal accounts.

Based on the interview with Chief Spence, the first storyboard and scenario set were created to visualize the use case for AR Incident Command technology. These deliverables serve to highlight problem areas Incident Commanders deal with because of communication issues. The team also created a Project Update Presentation which captured their key successes, key issues, and next steps.

Around this same time, the first draft of the dynamic prototype was completed. This prototype served as conceptualization of past research and designs to get an idea of what an augmented reality interface would need for incident commanders. The team conducted an additional interview with Chief Spence to review the current prototype and receive feedback on prescriptive data requests he would like to see. A few key aspects Chief Spence felt should be added to the current prototype included a small 3D map of the incident area to show its overall distribution, available resources, real-time data, thermal imaging, weather data, and indoor location data. These insights culminated into 2 additional scenarios and storyboards.

The group had previously planned to create an experience map to demonstrate their findings towards the end of this phase. After much deliberation and consulting with the client, the group decided to instead create a Journey Map because they felt it would better highlight their findings. This deliverable was moved to the next phase however as its later planned position in the phase made it difficult to adjust to before the interim report deliverable.

All other deliverables were completed successfully and to a high standard due to the insights learned in the interviews. The overall focus of the third phase was to gain enough knowledge from subject matter experts to highlight the use cases for the AR technology within incident command. This endeavor was successful, and the team can move forward as planned.

To conclude this phase, a third Interim Report was written and delivered to the project client demonstrating continued progress towards project objectives. Upon feedback, the group will

make any necessary changes to their current project plan and proceed with activities, as detailed in the Project Definition and Scope document.

In our fourth and final phase, the team will create a journey map to demonstrate the experiences and issues incident commanders have while responding to emergency situations. This map will be developed with the data collected in the interviews conducted in phase 3 of the project. In the following weeks, the team will also receive feedback on their project update presentation from 10 budding UX designers, developers, and researchers. The team will address any issues the group finds and modify their final phase plan accordingly.

The team will also finalize their dynamic prototype. This prototype will culminate the data they have collected thus far and assist them in the following week in conducting their tree testing with incident command professionals. This testing will help the team pinpoint any system issues that have gone unnoticed up until this point. It will also establish that they are still using industry standard conventions.

A fourth interim report will then be produced to provide an update on what was achieved in the last few weeks. This will be followed by a user interface requirements document which will establish the essential visual and interactive aspects of an augmented reality incident command system. Finally, a final report and presentation will be conducted that will culminate the entirety of the work done over the semester. These deliverables will also serve as essential starting points for future teams.

Overview

In the third phase of the project, we completed the following activities:

- **Completed interview with Kirk McKinzie (March 22)**
  - Kirk McKinzie provided answers as our team explored some questions detailing his experience and knowledge of any products related to incident command and control, situational awareness, and future technology adoption

- **Completed interview with Jacob Spence focused on scenario and storyboard creation (March 25)**
  - Chief Spence described an incident in-depth that he felt was unusually complicated and overwhelming. The incident described was the Civil Unrest of 2020.
  - Insights were gathered about the unpredictability and rapidly changing nature of incident command workflows.
  - A key scenario was identified for the design team to pinpoint areas of opportunity for the AR tool to assist.

- **Completed first scenario and storyboard detailing information gathered from Jacob Spence interview (March 29)**
  - To help designers visualize the use cases for the system, scenarios and storyboards were created.
  - This scenario highlights the problem areas Incident Commanders deal with because of communication issues.

- **Finalized the first draft of a dynamic prototype showing past research and designs to help conceptualize an idea of what the augmented reality interface will need for incident commanders (March 30)**
  - The prototype was created to help subject matter experts visualize some past research and design in a probable scenario
  - The use of common iconography and symbolism was utilized to keep standards intact and adoption among organizations high
  - Further development completed within phase 4 will add additional functionality, mostly related to asset and resource management, as well as command and control interfaces

- **Created a Project Update presentation that captured our key successes, key issues, and next steps (March 31)**
  - This presentation summarized the project scope and encompassed what the team has learned and performed on the project thus far.
  - In the next phase of the project, feedback will be received from outside sources into any insights or suggestions they have on the team's workflow.

- **Completed a second interview with Jacob Spence focused on the dynamic prototype, his feedback on the prototype, and continuing to identify key features the Augmented Reality Tool must have (April 1)**
  - The prototype was demoed to Chief Spence and received feedback about how effective the prototype is in conveying the intended experience.
  - Further insight was gathered into what features Chief Spence anticipates would be non-negotiable for creating an Incident Command "hub" in an Augmented Reality interface.

- **Completed two more scenarios and two more storyboards based off information gathered from second Jacob Spence interview (April 3)**
  - To help designers visualize the use cases for the system additional scenarios and storyboards were created.
  - Both scenarios highlight the use cases of AR Incident Command technology and how it addresses communication issues in the workflow of incident commanders. One scenario showcases a civil unrest incident, and the second showcases a large fire incident that requires indoor location tracking of personnel.

- **3rd Interim Report (April 4)**
  - The summary and overview were expanded to encompass what the team has learned and performed so far on the project.

What Was Learned

The third phase's focus was to gain enough knowledge from subject matter experts to enable us to create scenarios and storyboards highlighting use cases for the AR technology within incident command. Our second interview with Kirk McKinzie explored some questions detailing his experience or knowledge of any products related to incident command and control, situational awareness, and future technology adoption. Although brief, the answers our team received from Kirk allowed us to pursue some ideas and begin to build out scenarios. The last two interviews were with Jacob Spence who currently works in Incident Command. He was able to walk us through the Incident Command process he went through during the civil unrest of the summer of 2020. We gained valuable insight into the step-by-step process of managing such a large-scale incident, as well as what information was needed to make their decisions. For example, knowing where all assets and personnel are located, communicating with different teams and agencies, tracking news reports and traffic, and managing crowd control, among others. The interviews also emphasized that the biggest aspects missing in Incident Command now are better, real-time communication of information and data as well as precise location tracking of personnel and assets in the field. We then translated that into three scenarios accompanied by three storyboards that demonstrate how Incident Command works now, and two use cases for how it could work using the AR technology.

Kirk McKinzie (March 22)
Kirk McKinzie was able to briefly speak with our team in another shared group interview. Our questions were focused on large-scale incident commanding, current product fielding, and hurdles regarding the adoption of AR related technologies. The largest key findings we received from Kirk were:

- **Situational awareness** is one of the biggest problems in current incident command systems. There is a gap between what commanders know and what is happening. Lives and property are lost in a flash because of this time difference.
- The ability to track **triage status**, **civilian and responder health**, as well as calling in **additional resources** is all something that is extremely complex currently but would benefit from being offloaded to technology that is intuitive.
- There are **opponents to this technology** being added to workflows that have remained constant over the years. However, this **"technical revolution"** will be happening no matter what as these technologies and applications become commonplace among **civilians and responders** alike. What matters is how we can frame the experience to bridge that gap while also incrementally adding features along the way.
- Standards should be pushed that are **agnostic and ubiquitous** to allow for all devices, sensors, and software to easily combine and work together. This concept (and a long road ahead) will help users **adopt and become acquainted** with software and devices that are familiar to them, both in design and experience

Jacob Spence Storyboards/Scenarios Interview (March 25)
We conducted a semi-structured interview with Battalion Chief and Director of the Emergency Management Division of the Metropolitan Emergency Services Agency, Jacob Spence. The purpose of the meeting was to discuss the efficacy of the tools used throughout the command experience and identify areas of opportunity for technological improvement through observing inefficiencies. Chief Spence was asked to describe two scenarios in depth where he commanded an incident. He was asked to highlight the problems he encountered throughout incident command. The intended outcome of the meeting was that we would be able to generate feature ideas and requirements for the AR tool that will accommodate the identified areas of opportunity and fit usefully in the command workflow. We also had the objective of using the data in this interview to formulate scenarios where an AR tool could improve a command scenario. The following key findings were identified from this interview:

- Incident Commanders and Emergency Response Departments can typically rely on executing a pre-vetted plan during an emergency. However, there are some incidents with **variables** that plans simply cannot account for, and **real-time data** becomes even more invaluable.
- Commanders across different departments will collaborate on creating contingency plans using remote **collaboration tools**, such as Zoom and Google Maps.
- We captured an in-depth account of the 2020 Civil Unrest Incident from an incident command perspective.
    - Pain points in commanding the Civil Unrest Incident included
        - The **situational data changed rapidly** so it was difficult to keep up and adjust plans accordingly
        - It is **difficult to translate** audio data from radios and phone calls into a mental image.
        - Verbal accounts of a scenario are often **contradictory,** so it is challenging to form a clear mental image of an incident.
        - When collaborating with commanders remotely, **technical difficulties** can cost them valuable time that could be used for helping civilians through conducting a plan

We also asked Chief Spence to provide data points he imagined would have been helpful to him during this incident. He described the following:

- Seeing where **crowds** are
- Seeing where **911 calls** are coming in from
- Seeing where **critical infrastructure** is
- Seeing where **resources** already placed / need to be placed
- Data about incoming and current **weather**
- Seeing traffic patterns
- The **ability to place waypoints / incident markers** in the interface and map out a plan before executing it.

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Scenarios/ Storyboards (March 29, April 3)
The scenarios and storyboards served as an internal tool for the team to form a shared idea of how the AR tool would assist in incident command. Before we begin to create more specific UI/UX criteria and a journey map, we performed the exercise of storyboarding to form an agreed-upon perspective of what some of the problems in incident command are now and how augmented reality could be useful to commanders. It is also our hope that these storyboards and scenarios can serve to quickly paint a picture of these problems and solutions to future designers and researchers. Storyboard 2 was based on scenario 2 and quickly demonstrated how a command and chief would use AR to visually access an ongoing situation. What we learned from the storyboard was commanders would need to visual control and gain information.

Project Update Presentation and Peer Feedback (March 31)
The team created a presentation that captured our process up to this point, the deliverables we have created, the key findings we've deduced, and areas of opportunity we have identified. We expect to receive feedback from other student groups and anticipate the discovery of further resources and recommendations to our process going forward.

Jacob Spence and Dynamic Prototype Interview (April 1)
We conducted a semi-structured interview with Battalion Chief and Director of the Emergency Management Division of the Metropolitan Emergency Services Agency, Jacob Spence. The purpose of the meeting was to review the current 3D prototype and ask Chief Spence for prescriptive data requests he would like to see on the screen at a given time. The meeting was very enlightening, and we were able to form a rough list of feature requirements for the interface.

The key findings from the interview are a broad list of features that will be further refined in future interviews. The AR Tool should attempt to include the following features:

- Visually display a **3D map** of a small area to demonstrate the distribution of threats, field workers, resources, civilians, and areas of operation across the **x, y, and z-axis** to provide the operators with a situational awareness of the incident
- Develop a picture of available resources and assets, along with their status and other important information
  - Provide details about particular **resources**, such as individual **units**, **vehicles**, and even air assets like **helicopters** or **drones**
  - If available, **streaming cameras** attached to a unit can help the incident commanders place themselves at the scene
- Reflect updates **real-time** from data gathered at the incident
- Provide a **thermal imaging** setting to visually show **thermal mapping**
- Display **weather data**
- Provide **indoor-location data**

- ○ Identify where resources are located
  - ○ Identify collapsed areas or threats within an area
- Enable **remote collaboration**
  - ○ Multiple users can collaborate in the same environment without needing to be in the same room
  - ○ Users must have the ability to see exactly what another user is seeing from their perspective to facilitate a **common operating picture**
- Support users in **mapping out plans** before executing
  - ○ Placing staging areas, barricades, and placement of task forces and resource
  - ○ Allow multiple users to collaborate on the same plan
  - ○ Add drawing capabilities, using lines, points, and polygonal graphics
- Support users in **executing a contingency plan**
  - ○ Make updates to plan real-time in response to scenario
- Provide **direct messaging** and **group messaging**
  - ○ Can avoid overloading audio communication by adding chat communication
- Support **benchmarking** during operation execution
  - ○ Visually signify completed and pending benchmarks within the interface
- Maintain a clutter-free, simple, and easy to read interface
  - ○ **Filtering views** may be necessary to achieve this, so all data isn't visible at one time

Next Steps

Date	Action	Goals	Deliverable
April 8	Create a diagram to illustrate the journey of an incident command worker	Demonstrate the experiences and issues an Incident Commander will have while responding to an emergency	Journey Map
April 12	Adjust project plan based on feedback from peer review	Address any overlooked problem areas and ensure the best deliverable for future teams.	N/A
April 15	Complete a dynamic prototype to put form to the data collected thus far	Possess a rough design system which can be used for future evaluation	Dynamic Prototype
April 22	Evaluating the ease of use of our concepts and prototypes layouts	To pinpoint any un-identified issues and industry standards in terms of system layout	Tree-testing concepts and prototypes
April 25	Write up a fourth and final interim report to update project definition with scope	Provide status update of project objectives	4th Interim Report

April 29	Develop user interface requirements document for future teams	Explain all visual and interactive experiences necessary for the incident commander	User Interface Requirements Document
May 2	Write up a final report and present all the research, findings, and ideas	Communicate the progress made over the semester and finalize information delivered to future teams	Final Report and Presentation of Research

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Appendix A: Interview 5 Protocol and Notes

Time and Date:
Tuesday, March 22nd, 2022 at 11:00 am

Participant:
Kirk McKinzie - President McKinzie Smart Technologies LLC

Watch on Kaltura
Download Kirk McKinzie Interview 2 - 03_22_2022.mp4

- *If he could describe a recent scenario, start to finish, for how he commanded an incident that would be tremendously helpful.*
- **Have you been involved in any larger scale situations that required the setup of an incident command?**
    - Could you try and describe the processes and tasks you went through while commanding the situation?
        - Any large pain points? (he mentioned wildfires over vast amounts of land last interview)
        - Anything you would like to keep as is, except maybe digitized and adopted for the modern world?
    - ANSWER:
        - 10k emergencies, many as reserve firefighter, no where near command structure, looking to be told what to do
        - Made way up 15 years ago to acting captain
        - 1991 beverly hills fire
        - Biggest challenge for command is gap between reality and situational awareness
        - Calling in additional resources

- **We had the pleasure of the Indianapolis Fire Department giving us a tour of their incident command center as well as showing us the current software (provided by Motorola) they use daily for tracking calls and responding to emergencies. The software's mapping system alone could use an upgrade from it's very archaic 2D centered design.**
    - One issue we've thought about while researching this whole process is the large jump from these much older systems to systems that utilize wearables, such as the HoloLens, and how that might impact the workflow for the users given that they are cutting edge and familiarity may be low. There is also the training

aspect behind it all as well, and of course, everyone's favorite, the cost of updating systems.
- **Do you think that with the older chiefs, who are used to pen/paper/basic spreadsheets to fill out and update and who are retiring throughout the years, a technological revolution is upon us with the younger generation embracing new flows and concepts due to growing up with various devices and innovations?**

- **Two weeks ago in our original interview, you mentioned ATAK to me. I proceeded to download the Windows version and play around with it as well as do some research on how it's being used today. It seems that there is ALOT of setup and cost into getting full departments running on it, in fact you even mentioned last interview you were the only one in your department five years ago running it and without others to jump on board, ATAK kind of falls flat.**
    - We currently have identified the TAK product line as the only public facing software out there that could help emergency departments make the quicker jump to modern software based solutions with an emphasis on location tracking. Because of this, we feel its a strong contender to lead in design and ideas.
    - **What are your thoughts on standardizing local, state, and federal response teams on a piece of software like ATAK in order to get vast user acceptance and adoption? Any reason it isn't actively being pursued or implemented?**
        - We want to see what ideas and design concepts we can utilize and learn on common mapping software from before actively translating it into the 3D space for use in Augmented Reality.it
    - I've also researched and recognized that ATAK is a roll your own solution beast, that it merely performs well if the data entered into by the end user is setup to reflect accuracy. With that being said, not all users are capable of keeping

- **(broken record?) Last interview you mentioned that ICS is legacy by being utilized as a voice system most of the time, which can lead to miscommunication especially when time is of the essence. Do you believe that the use of various GUIs alongside with Voice to build a Common Operating Picture will lead to more lives and property being saved? Or will we need to be careful in the types of information that flow to users to keep them from being overstimulated cognitively?**
    - For an incident commander, what are the top five to ten (or more if needed) most critical pieces of data they need at any time?

Appendix B: Interview 6 Protocol and Notes

Time and Date:
Friday, March 25th, 2022 at 4:00 pm

Participant:
Jacob Spence - Director of Emergency Management for Marion County

Watch on Kaltura
Download Jacob Spence Interview 1 - 03_25_2022.mp4

The goal of the meeting:
- Define 1-2 scenarios in detail of where you commanded an incident

The purpose of the goal:
- Define problems in current command workflow
- Discuss tools used throughout
  - Cellphones
  - Whiteboards
  - Maps
  - Computers
  - Monitors
- Identify areas of opportunity
  - Parts that were frustrating or difficult
  - Inefficiencies in processes

Expected meeting outcome:
- Generate feature ideas and requirements for the AR tool that will accomodate the identified areas of opportunity and fit usefully in the command workflow.

1) Introduction. State the goals, purpose, and expected outcomes of the meeting
2) Gather basic background information:
   a) Years of experience
   b) Divisions worked in
3) Begin anecdote 1
   - Ensure probing occurs in regard to
     - Tools that are used
       - Efficiencies of these tools
     - Problems that occur
       - Why do they occur

- - - ■ What is their outcome
      - ■ Was there a way to prevent the error
    - ○ The success of the mission
      - ■ What enabled success
- 4) Begin anecdote 2
  - ● Ensure probing occurs in regard to
    - ○ Tools that are used
      - ■ Efficiencies of these tools
    - ○ Problems that occur
      - ■ Why do they occur
      - ■ What is their outcome
      - ■ Was there a way to prevent the error
    - ○ The success of the mission
      - ■ What enabled success
- 5) Ask for follow up meeting to review generated scenarios

NOTES

- ● Todo
- ● Jacob Spence
  - ○ Director of emergency management for marion county
    - ■ Main incident commander / liaison for large scale incidents / multi jurisdictional incidents
    - ■ Earthquake, tornado, civil unrest, flooding, snow storms, cyber security attacks, etc.
  - ○ Last appointment was captain in Indy FD
  - ○ Resource tracking
    - ■ Planning section chief (position)
      - ● Tracks resources / individuals that are assigned to an event / emergency incident & knowing their status / what they're doing / where they are
      - ● Could have 10-20 in a location / incident
      - ● Stage - ready to be assigned
      - ● Unavailable - reassigned, rear staging area
      - ● Rest / Rehab - worked the amount of time they're allowed before needing a break
- ● A typical week
  - ○ Mon - Fri 8-4
  - ○ Meeting w/ other agencies
    - ■ IMPD
    - ■ Planning, coordination for special events
  - ○ Coordinate county emergency operations plans

- - - Planning for countywide response & mitigation for flooding, snowstorms, tornadoes, etc.
      - Mandated by FEMA
    - Getting called out to anything that may pop up
      - E.g. Walmart fire, civil unrest, etc.
- Plans are re-written / updated depending on what type they are
  - All are gone through at least every 6 months
  - Make sure contact info is up to date
  - New fire stations, make sure info is up to date
- Scenario Walkthrough
  - Civil unrest of 2020 – most unexpected event he's dealt w/ in recent history
  - Started on the street behind their vehicles (friday)
    - By sat night using operation center at IFD headquarters
    - By sunday almost 40 people there
  - Fire, police, EMS all worked together
  - Hard to track and keep a good operational picture
  - Became clear pretty early on that it was something bigger, moved to operation center to have better real time information coming to them
    - Temp facilities – don't always have the same level of situational awareness
  - Moving to the command center gave better access to:
    - Police helicopter cameras
    - Drone footage
      - Need a way to display these which is at the op center
    - Real time tracking of units - computer screen
    - Live stream and feed news (multiple stations at once)
    - Make decisions on where to send responders based on the data
  - Decided to get more people involved on Friday night, by sat evening had most resources deployed where needed
  - Operation Period
    - Depends on the incident
    - As short as 15 min or as long as 24 hours
    - Large scale ops – break them down into 12 hr periods
      - Work, sleep, etc.
    - Try not to let people work long than 12 hr periods at a time – about the standard
    - In 1 12 hr period, planning for next 12 hr period
  - Friday worked till 5am, had to work next day at noon
  - Situation changed v/ rapidly
- Collaboration between commanders
  - Follow national guidelines
    - Unified command – all main jurisdictions
      - IFD, IMPD, Indiana state police, IEMS
  - Get together and plan goals for next operational period
    - Top level all the way down

- ○ Tenets:
  - ■ Life, safety, conservation
- ○ Elected officials – watching what they're doing, making sure they're doing what they should
- Tools
  - ○ Maps
  - ○ Layout of buildings
  - ○ Google maps
  - ○ Web X
  - ○ Zoom
  - ○ Teams – main virtual platform now
  - ○ What they do:
    - ■ Real time chat
    - ■ uploading of things that are happening
    - ■ Live spreadsheets
    - ■ ArcGIS/ESRI … look to get what layers he's using, works with prototype
- If safety issue involved, not their job to go into those areas
  - ○ If people are getting hurt, where do they make the breakdown where they help vs. not getting themselves hurt
  - ○ Saving people that are trying to hurt you
- Hearing on the radio
  - ○ Background noise, ambient noise makes it harder
  - ○ Masks make it harder
  - ○ Hard to translate what you're hearing into a good picture
    - ■ Firefighters having a hard time explaining what is happening
    - ■ Subjectivity
      - ● One person says 40 people, the other says 100 people
      - ● Truth is somewhere in the middle
- AR map data to see:
  - ○ Where crowds are
  - ○ Where 911 calls are coming in from
  - ○ Where problems are being reported
  - ○ Where critical infrastructure is
  - ○ Where resources already placed / need to be placed
  - ○ Weather
  - ○ Traffic patterns
  - ○ Ability to place waypoints / incident markers
    - ■ Barricades, etc.
  - ○ An existing technology
    - ■ Map that has landscape etc that allows them to see how a fire would spread
    - ■ Used to make plans before something happens
- Incremental approach

Appendix C: Scenario 1 - "Civil Unrest"

Civil Unrest

On Wednesday night, May 11th, 2020, a large group of protestors began to amass in downtown Indianapolis. The group is growing rapidly and reports of property damage begin to come into the IMPD. In order to assess the projected escalation of the event so as to plan for potential resource distribution, the Director of the Emergency Management Division at the Metropolitan Emergency Services Agency and Battalion Chief, Robert Jones, and his counterpart, Deputy Frank Meijers, drive downtown to gather situational awareness. Chief Jones is the head of Incident Command for the Metropolitan division and Marion County. The duo park near a collection of protestors running throughout the streets and destroying property. They step out of their car and begin reporting what they are seeing to the Incident Command Post.

Suddenly, Chief Jones dodges a bullet shot at him by a protester nearby. It has become clear to Chief Jones at this point that the incident is too large and unsafe to handle on the ground and he decides to command the operation back at the Incident Command Center. Once at the command center, he is receiving information from task forces and single resources on the scene about how the incident is progressing. He is **hearing contradictory observations**, with some reporting seeing groups of fifty people amassed, while others are reporting groups as large as 150 people.

Chief Jones listens intently and very carefully in order to form a clear mental model of the scenario downtown. He has **limited access to visual data** of the scenario due to a low level of drone deployment. Utilizing limited drone footage and contradictory audio data from radios, Chief Jones conducts a **contingency planning session** with incident commanders from the IMPD and EMS. They share the **limited knowledge** they have of the scenario, receive updates each moment, and create a plan for how to administer resources to contain the protestors, assist those who are injured, prevent escalation, and ensure preparedness in the case of escalation.

During the planning session, there are many **technical difficulties** caused by poor internet and screen sharing over Zoom. Much of the meeting is spent sharing information they had individually gathered up to this point to ensure everyone had a common understanding of the scenario. Once a **shared mental model** is roughly established, the commanders work together to form a common operating picture of the scenario and deploy the necessary resources.

Over the course of the incident, Chief Jones and his cross-departmental counterparts have greater access to information updates through increased drone footage, IMPD helicopter

cameras, and journalistic reports on the news. They use this data to determine the state of the scenario, reevaluate deployed resources, and eventually develop a plan for demobilization. Property damage does still accrue, however, the incident does not escalate to an unmanageable point. Chief Jones reflects on the incident as being one of **high stress** due to a **lack of real-time data** from the beginning and time wasted in planning meetings making sure all involved parties had the same mental model of the scenario.

Appendix D: Storyboard 1 - "Civil Unrest" (Part 1)
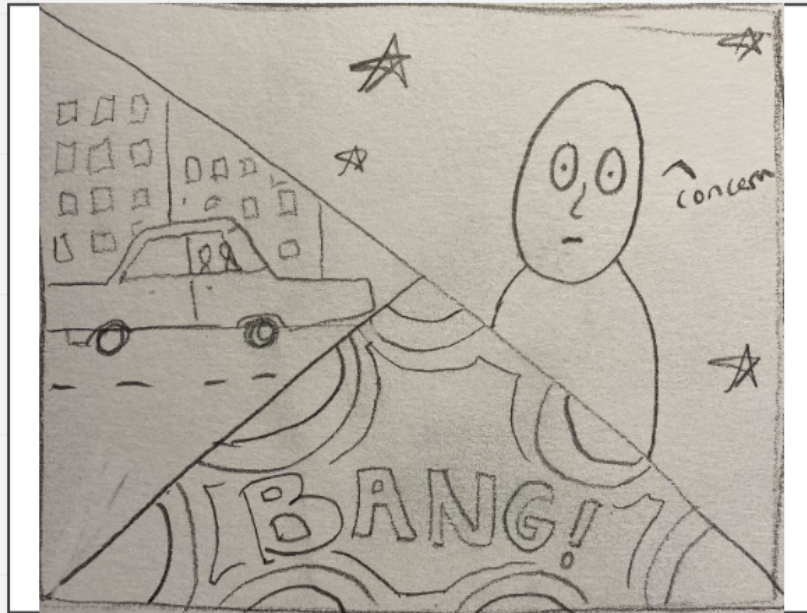
Trigger Action	
Reports of large crowds and property damage come in	
Who	Emergency Management Division at the Metropolitan Emergency Services Agency
Where	Indianapolis
What	The EMD is made aware there are large crowds amassing downtown and property damage has begun to accrue

Appendix E: Storyboard 1 - "Civil Unrest" (Part 2)

Discovery **Looking for Inspiration**	
Discovers danger and relocates	
Who	Chief Jones and Deputy Meijers
Where	On the scene downtown
What	Chief Jones attempted to size up the scenario but quickly realized the unsafe nature of it. He is shot at and immediately leaves the scenario.

Appendix F: Storyboard 1 - "Civil Unrest" (Part 3)
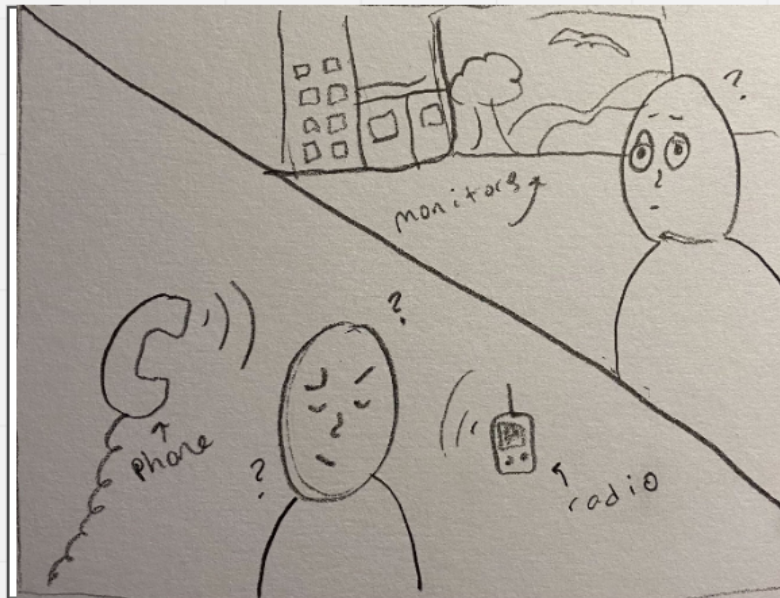
Journey Step Action	
Gathering contradictory audio data/limited visual Data	
Who	Chief Jones
Where	Incident Command Center
What	Back at the Incident Command Center, Chief Jones attempts to form a clear mental picture of how the scenario is developing by listening to radios and receiving limited visual data from drones.

# Appendix G: Storyboard 1 - "Civil Unrest" (Part 4)

Journey Step Action
Time wasted conversing with other Commanders to form COP

Who	Chief Jones and IC's and IFD, IMPD, and EMS
Where	Incident Command Center and remote calls
What	Chief Jones wastes time conversing with fellow commanders when trying to form a common operating picture before they can create a contingency plan. They experience technical difficulties over zoom due to poor internet connections.

Appendix H: Storyboard 1 - "Civil Unrest" (Part 5)
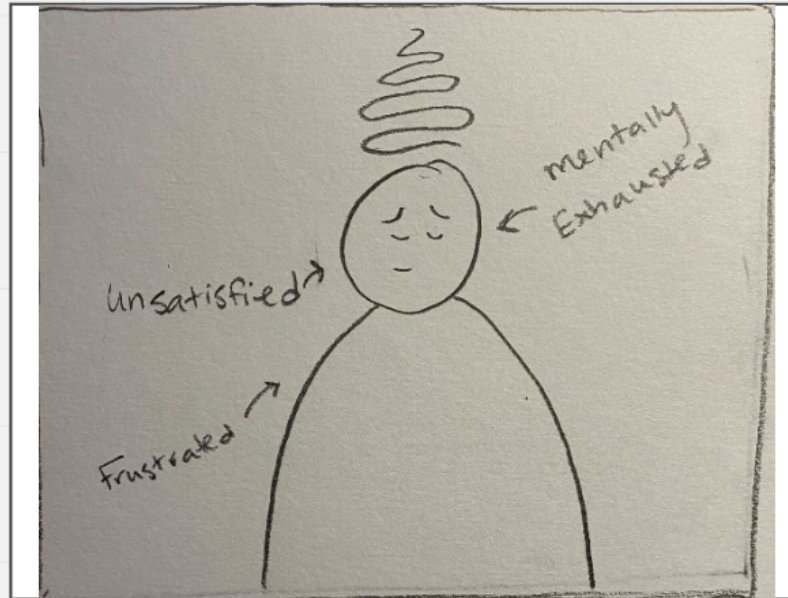
Conclusion	
Less than Satisfactory Ending	
Civil unrest mitigated but operation execution was high-stress and likely non-optimal	
Who	Chief Jones and IC's and IFD, IMPD, and EMS
Where	IC Center and Indianapolis
What	Though the civil unrest was mitigated, the commanders experienced many communication errors through the operation that they anticipate could have

Appendix I: Interview 7 Protocol and Notes

Time and Date:
Friday, April 1st, 2022 at 4:00 pm

Participant:
Jacob Spence - Director of Emergency Management for Marion County

Due to technical constraints and emergencies, no video recording is available

- Questions:
    - Where is the data coming from?
    - How quickly is it usable / rendering?
    - How much setup does this take?
    - Is the first person on the screen able to do this right off the bat?
- What we have in the prototype is more than what they currently get
- Top 5 data points that would be valuable to FF
    - Depends on the incident
        - Fire
            - Heart rate
            - Respiratory rate
            - Oxygen level
            - CO level
            - If someone is in an emergency status
                - Air supply in FF's air tank
- Live feed of a FF's view would be valuable
    - Thermal imaging
        - Available now, but only works for certain distances / has constraints
    - Body cams right now can be remote activated (police) – new tech
- Indoor location tracking
    - Nobody is doing Z axis tracking right now – people are trying
        - Part of the problem is how the signal is going out
        - Transmitters can be put around a building but it takes time
    - If possible, would be a huge help
- Would be useful to give commands using the interface
    - Current tech – some air packs let you send commands?
        - Through tones, hit a button to acknowledge
- Corner video feed of people talking?
    - Depends on the incident, could be useful in certain aspects
    - Could be too chaotic

- ○ Might be hard for tech to decode what they're saying e.g. industry terms / knowledge
- Having everyone be able to look at the same thing is huge
  - ○ If dispatch center can also view it that would be a huge help
  - ○ Ability to see / know who is logged in
  - ○ Chat function would be useful – cut down on radio traffic
- Things in an incident that cause them to decide how to assign resources
  - ○ Smoke conditions
  - ○ Fire conditions
  - ○ Reports on interior of the fire
  - ○ Time
    - ■ They get 15 min benchmarks (reported by dispatchers)
- Something that could give a warning before building collapse would be helpful
- Icons
  - ○ Standardize national iconography
  - ○ Most of the icons in the prototype look correct
  - ○ Having standard icons as well as some options would be good
    - ■ Other people might want to be able to customize them
- Ability to turn off certain layers / information to make it less busy
- Liked the idea of being able to draw out lines / squares and mark them with icons
- Needs to be as simple as possible so people can use it quickly and intuitively
  - ○ Approachable
  - ○ Uncomplicated interface
  - ○ Give basic features right off the bat, plus additional features for those who want to dive in
    - ■ Don't want to need to know a lot to be able to start using it
- Benchmarking would be useful
  - ○ E.g. make a floor green if it's clear

Appendix J: Scenario 2 - "Civil Unrest with ICAR Tool"

Civil Unrest with ICAR Tool

On Wednesday night, May 11th, 2020, a large group of protestors began to amass in downtown Indianapolis. The group is growing rapidly and reports of property damage begin to come into the IMPD. The Director of the Emergency Management Division at the Metropolitan Emergency Services Agency and Battalion Chief, Robert Jones, places his ICAR (Incident Command Augmented Reality) Tool over his eyes and slips the corresponding haptic feedback gloves over his fingers. **In an instant,** he is able to see a **3D rendering of the city of Indianapolis** and zooms in using his fingers to identify where the crowds of people are beginning to amass. **Real-time data** is being used to update the map, and Chief Jones is able to see where property damage has occurred, which direction the crowds are moving, traffic patterns, where 911 calls are coming in from, and where specific incidents are being reported.

He wastes no time and asks Lead Incident Commanders from the IMPD, EMS, and IFD to join him on the **collaborative** ICAR tool. Shortly thereafter, the fellow commanders are able to see the same map with the same real-time data live on a call with Chief Jones. They are connected by an audio component in the ICAR and are able to converse. In minutes, the group is able to create a contingency plan and execute immediate deployment of resources. Chief Jones communicates his ideal resource distribution by placing virtual symbolic components that represent task forces, areas of operation, resources, waypoints, and graphics on the 3D map that can be viewed by all the commanders.

The fellow commanders **collaborate** with Jones in this effort by adding or taking away their desired resources represented by symbolic components. The experience feels comparable to laying out a strategy on a game board using tangible tokens. They feel **confident** that they have an optimal strategy for managing the incident because they know there are no discrepancies between their various perspectives of the incident; they were all looking at the same data at the exact same time to form the **common operating picture.**

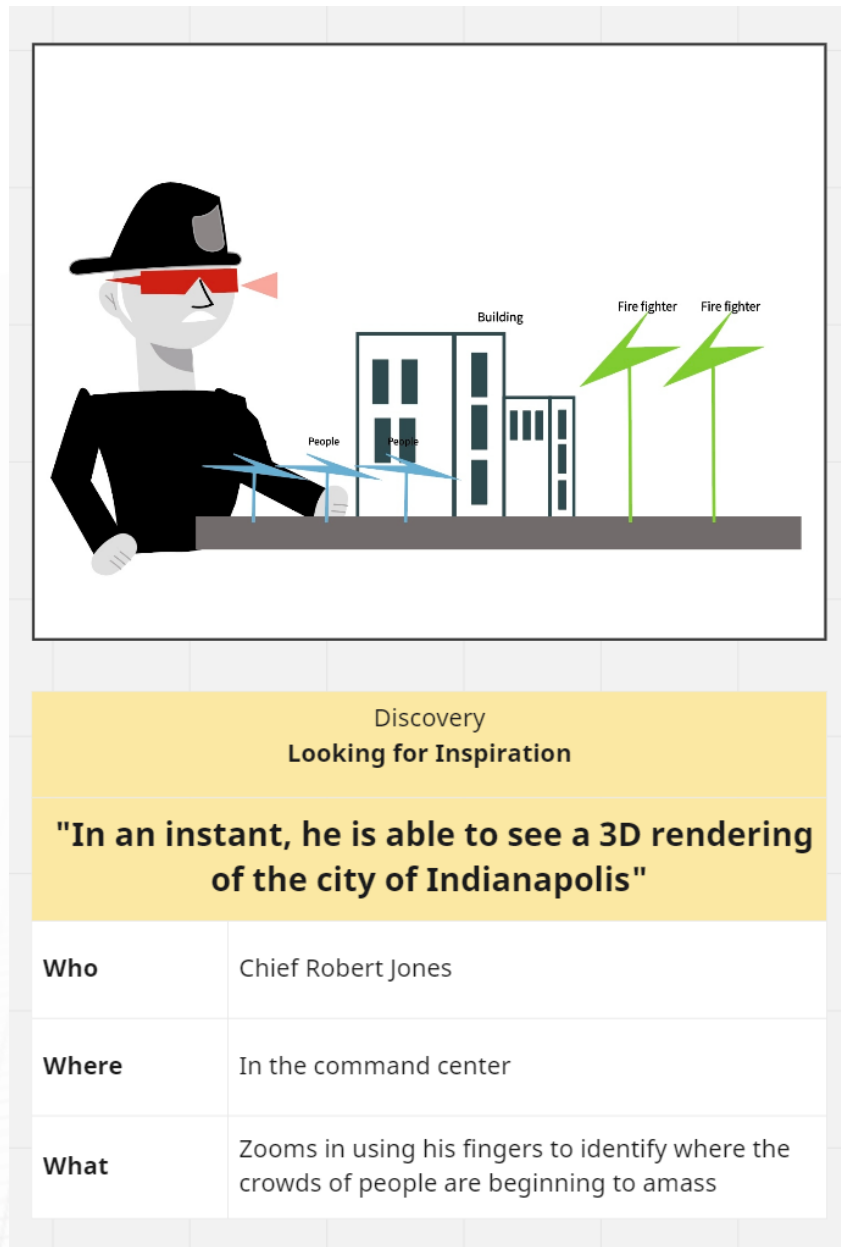# Appendix K: Storyboard 2 - "Civil Unrest with ICAR Tool" (Part 1)

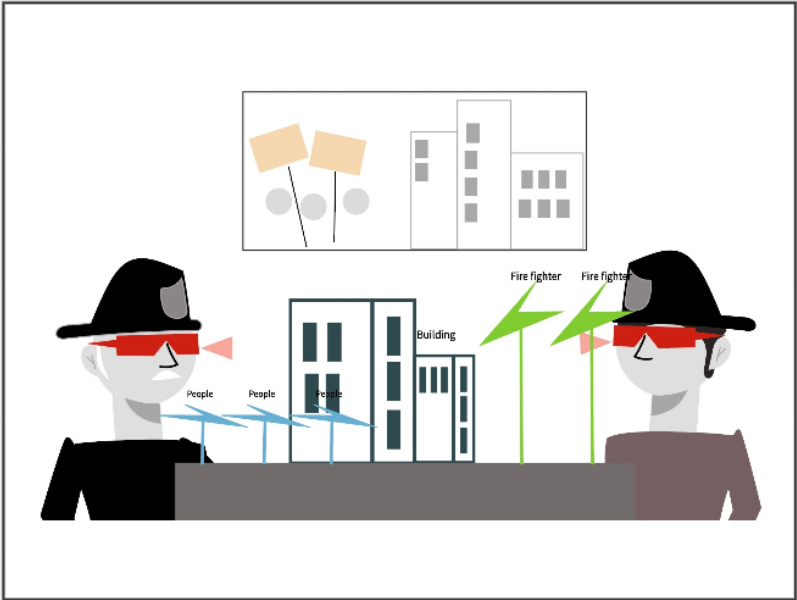| Trigger Action	
"A crowd is forming, and Robert needs to assess the situation"	
Who	Chief Robert Jones
Where	Night Downtown Indianapolis
What	Places his ICAR (Incident Command Augmented Reality) Tool over his eyes and slips the corresponding haptic feedback gloves over his fingers

Appendix L: Storyboard 2 - "Civil Unrest with ICAR Tool" (Part 2)

[Download Full Storyboard (AR in COP - Storyboard 2 - Civil Unrest with ICAR Tool v1 - 04_03_2022.png)](#)

| Discovery	
Looking for Inspiration	
"In an instant, he is able to see a 3D rendering of the city of Indianapolis"	
Who	Chief Robert Jones
Where	In the command center
What	Zooms in using his fingers to identify where the crowds of people are beginning to amass

Appendix M: Storyboard 2 - "Civil Unrest with ICAR Tool" (Part 3)

[Download Full Storyboard (AR in COP - Storyboard 2 - Civil Unrest with ICAR Tool v1 - 04_03_2022.png)](#)

Journey Step Action	
"Fellow commanders are able to see the same map with the same real-time data live"	
Who	Chief Robert Jones with other commanders
Where	In the command center
What	Connects with other commanders to establish resources

Appendix N: Storyboard 2 - "Civil Unrest with ICAR Tool" (Part 4)
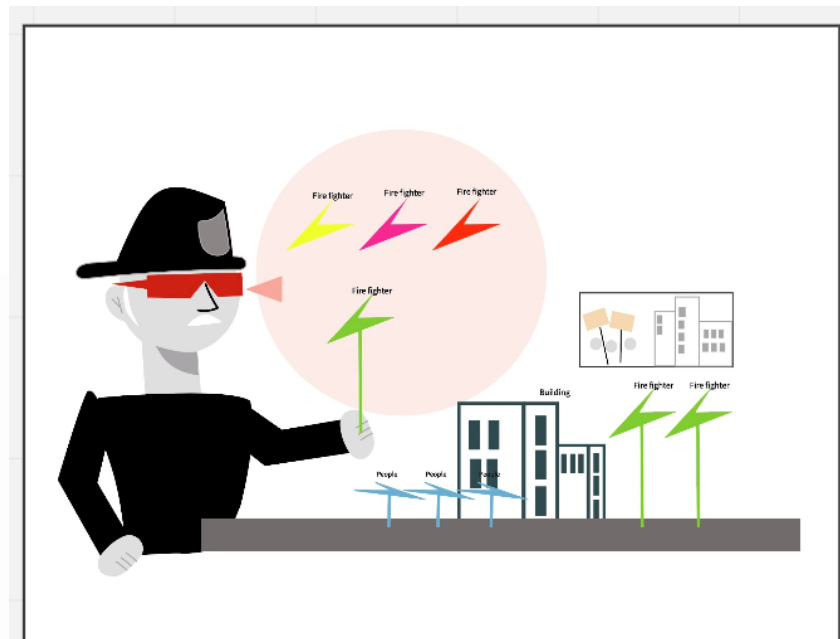
Journey Step **Action**
"Placing virtual symbolic components that represent task forces"

Who	Chief Robert Jones with other commanders
Where	In the command center
What	Add resources on the map and creates a plan

Appendix O: Storyboard 2 - "Civil Unrest with ICAR Tool" (Part 5)

Conclusion	
Happy End	
"Robert is able to collaborate with fellow commanders"	
Who	Chief Robert Jones with other commanders
Where	In the command center
What	The fellow commanders collaborate with Jones in this effort

Appendix P: Scenario 3 - "Managing the Civil Unrest and Unexpected Fire Emergency with ICAR Tool"

Managing the Civil Unrest and Unexpected Fire Emergency with ICAR Tool

As the scenario progresses, Chief Jones is keeping his eye on the operation from the safety of the Incident Command Post. He is able to send direct messages to managers and deputies and oversee all parties involved in the overseeing of containing the civil unrest. On the second day of the event, a fire breaks out at the Indianapolis Convention Center. Chief Jones Coordinates with Incident command at the IFD to ensure the necessary fire control resources can be distributed without taking too many away from other fire control stages of the civil unrest operation. Battalion Chief and Head of Incident Command at the Indianapolis Fire Department, Bridgette Warner, uses the ICAR Tool from her position at the IFD Headquarters to create a contingency plan for putting out the fire at the Indianapolis Convention Center. Chief Warner is able to zoom into the convention center and view real-time data about the smoke conditions, fire conditions, weather conditions, and potential civilian safety risks. She places symbolic components that represent task forces and single resources on the map where she would like them to perform and confirms deployment. She watches the resources she commanded fall into place in real-time, making updates to the operation as needed.

When boots-on-the-ground field workers make it to the scene, they enter the building to find and rescue human beings. Chief Warner is able to observe where her firefighters are in the building, even where they are inside the building, utilizing an indoor tracking feature of the ICAR Tool. Field operators identify barricaded hallways, areas where the fire has spread to an impenetrable level, and where civilian recoveries are occurring using corresponding data collection technology in their suits. The ICAR Tool displays this data on the 3D Map for Chief Warner to see. Chief Warner notices one firefighter leaves the burning building without a buddy, breaking the golden two-in-two-out rule. She writes a message using a virtual keyboard in the ICAR Tool to the identified firefighter asking for a status report. The corresponding firefighter hears an AI-generated text-voice message with her questions and verbally replies that he has lost his buddy. He provides the lost firefighter's ID number and Chief Warner is able to search for him on the ICAR Tool map. The lost firefighter's position is highlighted on the map and she is able to provide exact directions to his location to the team leader. The fire team leader on the scene conducts a search and rescue for the firefighter and he is found before his vitals reached

a state of alarm. The fire was successfully put out and all field operators survived the operation.

Appendix Q: Storyboard 3 - "Managing the Civil Unrest and Unexpected Fire Emergency with ICAR Tool" (Part 1)

Trigger **Action**	
A fire breaks out at the Indianapolis Convention Center	
Who	Chief Warner
Where	Indianapolis Fire Department Headquarters
What	Chief Warner uses the ICAR tool to create a contingency plan, assign resources, and command the situation.

Appendix R: Storyboard 3 - "Managing the Civil Unrest and Unexpected Fire Emergency with ICAR Tool" (Part 2)

	Discovery **Looking for Inspiration**
	Observing where the firefighters are in the building
Who	Chief Warner
Where	Indianapolis Fire Department Headquarters
What	Chief Warner zooms into the convention center using the ICAR tool and tracks her firefighters using the indoor tracking feature.

Appendix S: Storyboard 3 - "Managing the Civil Unrest and Unexpected Fire Emergency with ICAR Tool" (Part 3)

[Download Full Storyboard (AR in COP - Storyboard 3 - Managing the Civil Unrest and Unexpected Fire Emergency with ICAR Tool v1 - 04_03_2022.png)](#)
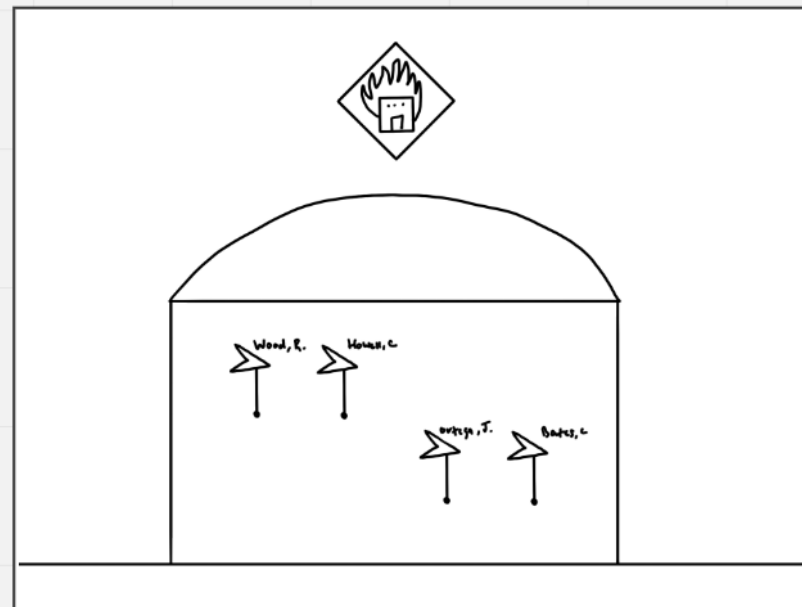

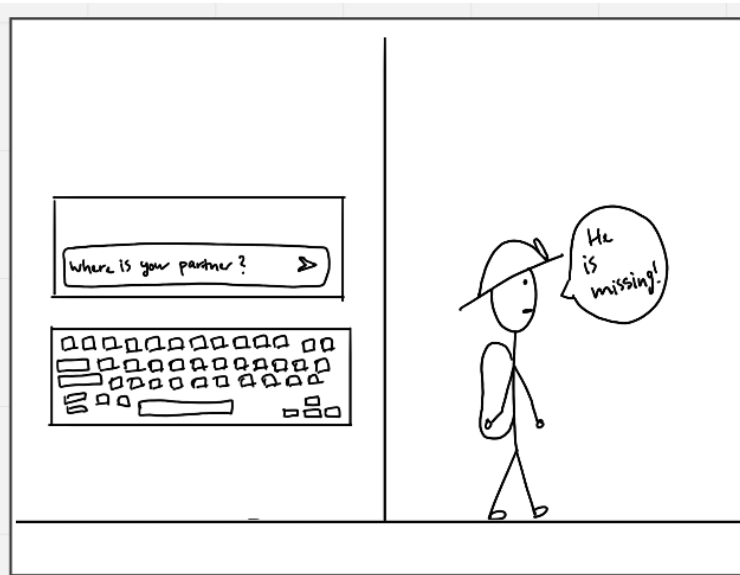
Journey Step Action	
Contacting a firefighter and receiving a reply	
Who	Chief Warner and a firefighter
Where	IFD HQ and the convention center
What	Chief Warner notices that a firefighter leaves the building without his partner. She notifies him using the virtual keyboard of the ICAR tool which is read to the firefighter with an AI-generated voice message. The firefighter responds verbally that his partner is missing.

Appendix T: Storyboard 3 - "Managing the Civil Unrest and Unexpected Fire Emergency with ICAR Tool" (Part 4)

Journey Step Action	
Locating a specific firefighter on the map	
Who	Chief Warner
Where	Indianapolis Fire Department Headquarters
What	Chief Warner uses the ICAR tool to locate the firefighter's partner and sends him his location.

Appendix U: Storyboard 3 - "Managing the Civil Unrest and Unexpected Fire Emergency with ICAR Tool" (Part 5)

Conclusion **Happy End**	
The firefighter is found and rescued	
Who	Firefighters
Where	Convention Center
What	The firefighters on the ground use the location given by Chief Warner to find the missing firefighter and successfully rescue him from the fire.

Appendix V: Project Update Presentation

[Download AR in COP - Project Update and Next Steps - 04_02_2022.mp4](#)
[Download AR in COP - Project Update and Next Steps - 04_02_2022.pdf](#)

Appendix W: Annotated Bibliography

[Download Full Annotated Bibliography (AR in COP - Annotated Bibliography.pdf](#))

Data Collected

Augmented Reality Device for First Response Scenarios - March 16th, 2022:
This paper discusses a prototype of a wearable computer system that allows for access to location-specific information about an environment, and the capability for user tracking. Its applicability is primarily discussed for use in first response scenarios.
- **[Download Augmented Reality Device for First Response Scenarios.pdf](#)**

NIST Delivering Building Intelligence to First Responders - March 16th, 2022:
This paper discusses the challenges of delivering building intelligence information to firefighters. It also presents a summary of current state-of-the-art technology in this area and provides insight into how to address these challenges.
- **[Download NIST Delivering Building Intelligence to First Responders.pdf](#)**

HPHSCC - 2017 Active Shooter Planning and Response in a Healthcare Setting - March 16th, 2022:
This booklet discusses basic information and difficult to answer questions when it comes to safety in an active shooter situation occurring in a healthcare setting. This information is based on expert review and specifically covers patient, visitor, and personal safety, duty to act, and abandonment.
- **[Download HP HSCC - 2017 Active Shooter Planning and Response in a Healthcare Setting.pdf](#)**

Intelligent Dashboard for Augmented Reality Based Incident Command Response Co-ordination - March 16th, 2022:
This paper describes an Intelligent Dashboard for incident commanders that provides augmented reality benefits with minimal human communication through IoT devices. These devices include such as heads-up displays, virtual beacons, QR-code cards, and wireless mesh network elements. Usability evaluations are conducted to show the ease-of-use and effectiveness of the dashboard.
- **[Download Intelligent Dashboard for Augmented Reality Based Incident Command Response Co-ordination.pdf](#)**

Recorded Interview with Kirk McKinzie - March 22nd, 2022:
Kirk McKinzie provided answers as our team explored some questions detailing his experience and knowledge of any products related to incident command and control, situational awareness, and future technology adoption
- **Watch on Kaltura**
- **Download Kirk McKinzie Interview 2 - 03_22_2022.mp4**

Recorded Interview with Jacob Spence - March 25th, 2022:
Chief Spence described an incident situation in-depth that he felt was unusually complicated and overwhelming. The incident described was the Civil Unrest of 2020.
- **Watch on Kaltura**
- **Download Jacob Spence Interview 1 - 03_25_2022.mp4**

ARTAK Informational Brief - March 30th, 2022:
An informational brief on the Augmented Reality Tactical Assault Kit which helps soldiers to plan missions. The presentation shows detailed images of the process and its capabilities.
- **Download ARTAK Informational Brief.pdf**

Project Update and Next Steps - April 2nd, 2022:
The teams Video Presentation and Slides which served to update the class on the project scope, the steps they have completed since beginning the project and intended plans as they move forward. Includes the deliverables they have created thus far, and the key issues the team is facing.
- **Download Project Update and Next Steps - 04_02_2022.mp4**
- **Download Project Update and Next Steps - 04_02_2022.pdf**

ICS 100 - Incident Command System - USDA.gov - April 3rd, 2022:
This report serves as an overview of the Incident Command System (ICS). It details what the ICS is, its history, applications, its interdisciplinary and organizational flexibility and how it serves as the standard for emergency management across the country.
- **Download ICS 100 - Incident Command System - USDA.gov.pdf**

References

Federal Bureau of Investigation. "Improving Our View of the World: Police and Augmented Reality Technology." n.d.

> *https://www.fbi.gov/file-repository/stats-services-publications-police-augmented-reality-technology-pdf/view*

This report serves as an introductory document on Augmented Reality to the policing profession. It discusses principles and components of the technology as well as its newest developments. It also covers potential applications for future use of this technology.
- **Direct Web Link**
- **Download FBI.gov - Police and Augmented Reality Technology.pdf**

US Fire Administration. "Incident Command System and Resource Management for the Fire Service" n.d.

> *https://apps.usfa.fema.gov/nfacourses/catalog/details/10557*

This report serves as a tool to teach about the Incident Command System (ICS) and Resource Management for the Fire Service and their application in both emergency and nonemergency situations. It covers the need for an ICS, an overview of the structure and flexibility of ICS, and an understanding of the command skills necessary to function effectively in an ICS structure and the need to effectively manage your resources.
- **Direct Web Link**
- **Download National Fire Academy - Incident Command System and Resource Management for the Fire Service.pdf**

California's All Hazards. "Situation Awareness and Collaboration Tool Concept of Operations." n.d.

> *https://www.caloes.ca.gov/Cal-OES-Divisions/Regional-Operations/Situation-Awareness-and-Collaboration-Tool*

SCOUT is a web-based tactical and operational response platform that assists in communication, coordination, and collaboration within incident management for all hazards, whether natural or human-made. It was made for the California first responder community and supporting agencies. Authorized users can view, search and add relevant tactical incident information for a variety of incident types, including wildland fires, floods, search & rescue missions, special events, earthquakes, and homeland security incidents.
- **Direct Web Link**
- **Download Situation Awareness and Collaboration Tool (SCOUT).pdf**

NAPSG Foundation. "Symbol Library" n.d.
   https://www.napsgfoundation.org/all-resources/symbology-library/
The NAPSG Foundation has been working with the Department of Homeland Security to develop a consistent incident symbology framework. These symbols have helped us add commonly accepted and standard iconography for various incidents within the dynamic prototype. This library is a representation of in-use and current symbology that incident commanders should be familiar with and covers a vast range of incident, hazard, and resource iconography.

- **Direct Web Link**
- **Download NAPSG Foundation - Symbol Library.pdf**
- **Download NAPSG Foundation - Symbol Library.zip**

Appendix X: Project Definition and Scope

[Download Project Definition and Scope (AR in COP - Project Definition and Scope.pdf](#))

Summary of Project

The Indiana University Crisis Technologies Innovation Lab (IUCTIL) is in the process of developing an augmented reality (AR) design system that assists both incident commanders and first responders in resolving emergency situations in an efficient manner. The future innovations and use of AR within heads-up displays (HUDs) have already proven to be a viable asset in many hands-on industries. Utilizing research and data from interviews, cognitive analysis, and other user experience design techniques, we are looking to uncover what most incident command operators are wanting in a futuristic environment that incorporates the use of AR. Features, workflows, client requirements, and proper contextual user-centered design will be at the forefront of recommendations to a design and development team that will create prototypes. The anticipated research and work from this project will impact the following:

- Demonstrate the value of precise location-tracking, asset management, and other necessary data within incident commander workflows

- Demonstrate the value of using AR in emergency scenarios to assist with situational awareness and decision making while saving more lives compared to conventional measures

- Generate user interface and experience design criteria and requirements for an augmented reality interface

- Recommend a standardized interface and design restraints from requirements set by incident commanders and first responders

Incident command personnel will be the focus of this project; specifically, commanders that work directly with first responders. Understanding their workflows, problems, and goals will be paramount to our research on using augmented reality when performing duties.

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The Project Goals

To accurately conceptualize and recognize the user experience in augmented reality for incident commanders, five (5) main goals have been defined:

1. **Understand the current workflow of incident commanders in emergencies**
   a. The current toolsets being used, the steps taken to accomplish tasks, finding the data and information necessary to achieve goals, and other potential cognitive processes involved
   b. Understanding AR is secondary—this is not our focus when receiving user feedback
   c. Attempt to fix problems that incident commanders have when responding to emergencies and propose solutions

2. **Learn what smart-tracking or indoor location-tracking interfaces and ideas would benefit incident commanders**
   a. Investigate the data that is useful to the incident commander and determine how detailed it needs to be
   b. Discover the usefulness of their current toolset and how future effort can iterate and improve upon the incident commander's productivity and flow
   c. Explore what information is currently available for an incident commander during an emergency and uncover any unknown data points that would be beneficial

3. **Investigate the use of location-tracking and other techniques to assist in workflow enhancement**
   a. Demonstrate the value of highly accurate location-tracking in workflows
   b. Validate the use of AR in these settings to assist with situational awareness and decision making
   c. Research if AR can assist current incident commander workflow regarding role assignment, asset management, and resource allocation with a heavy emphasis on location-tracking

4. **Research the benefits of augmented reality interfaces and controls when creating common operational pictures (COP)**
   a. Identify current processes, designs, and tasks that COP applications utilize
   b. Explore tools that handle COP workflows and understand why or how they deliver experiences for their users
   c. Investigate the addition of AR within these interfaces and tools to verify advantages and disadvantages
   d. Discover if modern AR concepts have enhanced experiences for their userbases, particularly for indoor location-tracking, command and control, and other similar situations, such as emergency response

5. **Gather enough ideas and concepts to easily hand-off user interface requirements to an external development team**
   a. Prepare UX design criteria with AR techniques at the forefront
   b. Create workflows for designers and developers to build and materialize
   c. Deeply understand user workflows and how AR would best fit within them
   d. Design AR specific features and functionality at a prototyping level
   e. Find the high-value tasks in incident command workflows and capture them accurately for AR experience purposes

These outlined goals will keep our focus and priorities on client requirements while delivering detailed recommendations about our target user base.

Expected Activities and Deliverables

For each of our project goal's success, multiple activities and deliverables have been identified. The efforts will range from collecting various sets of data and research, conducting interviews with multiple subject matter experts, and developing documents that will help the next team understand what users will require in their workflows and tasks.

1. **Interviews with subject matter experts**
   a. Conduct seven (7) or more interviews
   b. Initial interview will assist in further defining the scope of the project
   c. Second interview will target our users' workflows and understanding their wants, needs, and problems
   d. Third interview will help define persona attributes, needs, wants, and problems
   e. Fourth interview will be explicitly about task-analysis and investigating what works well, what doesn't work well, and what can be improved
   f. The fifth interview will be about reviewing all effort completed with an expert and assist with creating suitable scenarios and storyboards
   g. Two (2) interviews will be conducted with a subject matter expert who is involved in the augmented reality space and has an understanding of how AR can help ICS; may also get more industry connections from these interviews as well
   h. All interviews will attempt to help understand workflows of emergency personnel, information that is necessary or beneficial for the actual user, and conceptualize modern interfaces that can use AR to enhance experiences
   i. Visit in-person the various facilities that today's incident commanders will use when responding to emergency situations or large events

2. **Persona development**
   a. Three (3) unique personas will be developed
   b. Each persona will be idealized as personnel on different command levels in an incident command system hierarchy
   c. These personas will help future developers understand the types of users that are envisioned to use this technology and help guide their team in the right direction

3. **Affinity map**
   a. Using an affinity map will help organize findings, ideas, and pursue concepts uncovered throughout the project
   b. The affinity map will assist in defining common themes through qualitative data gathered from the informal interviews conducted. This data will be used to help create personas that will enable designers to greater empathize with the future end users

4. **Empathy map**
   a. An empathy map will guide us through visualizing our target users' behaviors and create a deeper understanding of their mindset

      b. An empathy map will facilitate a shared understanding of the users' needs and perspectives among the design team and client

5. **Experience/journey map**
   a. The experience of what the user goes through when accomplishing tasks and goals will need to be properly visualized through the use of an experience map
   b. The experience map will serve to illustrate the user's journey through an emergency scenario using AR technology. The map will be used by future designers to empathize with the users and recognize the key parts in the user's journey that are impacted by the design

6. **Scenarios and storyboards**
   a. Scenarios will help with predictions on user behavior while delivering potential experiences and interactions
   b. To help properly explain a journey (story) the user participates in, storyboards can give a visual representation. The story boards will be used to demonstrate the value of using AR technology to enhance situational awareness

7. **Tree-testing**
   a. A tree test will be prepared to discover any usability or findability issues within smaller pieces of an interface
   b. Evaluation of users performing tasks on mock navigations
   c. Explore different exploration outcomes that would benefit users in completing a task

8. **Secondary literature review**
   a. Reviewing previous research will uncover solutions and problems that other research teams have encountered. Some examples of this research include:
      ● A framework for AR Usability Evaluation in the public safety communication research realm (**PSCR 2021: Augmented-Reality (AR) Usability Evaluation Framework for PSCR**)
      ● Presents grants and funding opportunities for AR in public safety communications research, as well as descriptions of ongoing projects (**PSIAP Augmented Reality (AR) Funding Opportunity**)
      ● Research portfolio for User Interface / User Experience work with the public safety community (**NIST User Interface/User Experience Research Portfolio**)
      ● Description of the CHARIoT Challenge in which participants built AR interfaces or IoT data emulators for first responder communications (**2020 CHARIoT Challenge: Advancing First Responder Communications**)
      ● A roadmap for planning public safety communications research (**Public Safety User Interface R&D Roadmap**)

9. **User Interface Requirements Document**
   a. After analyzing tasks, feedback, and other requirements, a document will be created to help guide future development teams

b. Various user interface designs that are proven necessary for the user will be recommended
c. The document will contain research artifacts, such as the personas, empathy map, experience map, and more, to enable future designers to grasp the context for which they will be designing.

10. Dynamic Prototype
a. Take previous researched design ideas, concepts, and interfaces to build out a prototype that can help incident commanders visualize a system
b. The prototype would utilize feedback from subject matter experts and current design flows
c. The prototype would also act as an "incremental" step towards a software solution that was built with incident command and emergency response in mind

The expected activities and deliverables will assist in developing a better understanding and thought process for the design and development team in their effort on creating viable features and prototypes.

The Project Timeline
Four Phases, January 31 – May 2

The expected timeline has been outlined for the next four months and broken out into individual phases. All actions and deliverables are tentative. If any changes or updates happen, the timeline will be refreshed accordingly.

PHASE 1	
January 31 – February 21	
ACTIONS	**DELIVERABLES**
- Continue reviewing secondary literature and researching applicable material - Perform interview with subject matter expert utilizing a developed protocol in collaboration with a different team - Update the project definition and scope from feedback given within interview and from client - Create the first interim report on success and failures for the project	- January 31 - Initial draft of Project Definition and Scope - February 11 - Complete interview with Subject Matter Expert - February 21 - Revised Project Definition and Scope - February 23 1st Interim Report

PHASE 2
February 22 – March 15

ACTIONS	DELIVERABLES
- Pursue a second interview with a knowledgeable candidate that can help define our future persona attributes, wants, goals, and problems - Invited to a tour of the IMPD's incident command center to get a better understanding of our user's environment - Develop an affinity map based off research and interview feedback - Connect with and interview with a leading expert in AR tech with an emphasis in incident command systems - Develop two (2) unique personas that are representations of users within an incident command structure - Develop an empathy map for each persona that targets four main areas: what things they are saying, thinking, doing, and feeling - Produce a second interim report and potentially update project definition and scope	- February 25 - Complete interview with focus on building personas - March 2 - Tour of Incident Command Center - March 5 - Affinity Map - March 8 - Interview with AR subject matter expert - March 10 - Empathy Map - March 13 - Personas Document - March 14 2nd Interim Report

PHASE 3	
March 16 – April 6	
ACTIONS	**DELIVERABLES**
- Complete the second interview with the AR subject matter expert on more specifics with what is being fielded today - Complete interview to help develop scenarios and storyboards based on real incidents - Implement past research and development of augmented reality design systems in a rough dynamic prototype - Based off interviews and research completed this phase, produce scenarios and storyboards that help conceptualize the incident command workflow in AR - Create a presentation detailing key success, key issues, and next steps for peers to present feedback - Produce a third interim report and potentially update project definition and scope	- March 22 - Complete second interview with AR subject matter expert - March 25 - Complete interview focused on building scenarios and storyboards with ICS subject matter expert - March 29 - First Scenario - First Storyboard - March 30 - First draft of dynamic prototype - March 31 - Project update presentation to get feedback from UX peers - April 1 - Complete second interview with ICS subject matter expert focusing on dynamic prototype and features - April 3 - Two more scenarios, focused on AR tooling - Two more storyboards, focused on AR tooling - April 4 3rd Interim Report

PHASE 4	
April 7 – May 2	
ACTIONS	**DELIVERABLES**
- Demonstrate the experiences and issues an Incident Commander will have while responding to an emergency situation with a journey/experience map - Address any overlooked problem areas and ensure the best deliverable for future teams - In addition to the work/activity model, perform tree testing on prototypes, sketches, or wireframes. Depending on the results, research user feedback and create a document detailing pros and cons. This will be presented to a subject matter expert for testing purposes - Since this research is being handed off to an external team, develop user interface requirements that will explain all visual and interactive experiences necessary for the incident commander. This effort will build on previous research and create/innovate where there are gaps - Present all the research, findings, and ideas in one final report and presentation	- April 8 - Journey/experience map - April 15 - Finalize dynamic prototype - April 22 - Tree-testing concepts and prototypes - April 25 4th Interim Report - April 29 - User Interface Requirements Document - May 2 - Final Report and Presentation of Research

Conclusion

Our team is excited to explore the first responder's cognitive work flow during times of crisis to analyze how many enhancements can be completed regarding their situational awareness. First responders and other emergency personnel place their own lives on the line every day to assist the general public. Our belief is that augmented reality interfaces and controls can assist in streamlining their processes with innovative technology and utilizing modern concepts. We hope the future of our work results in saving the lives of many for generations to come.