DiVE Lab- Duke University

Requirement Analysis and Participatory Design of Next Generation Public Safety User Interfaces

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Jerônimo G. Grandi, Ph.D. – Postdoctoral Associate

Mark Ogren – IT Analyst, Research Volunteer

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About Us

Regis Kopper

- Project Principal Investigator
- Director of the DiVE Lab

Jeronimo G. Grandi

- Postdoctoral Associate – DiVE Lab
- Ph.D. in Computer Science

Mark Ogren

- IT Analyst at Duke
- User Services Specialist
- Volunteer

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Project Motivation

- Project title: Design, Prototyping and Evaluation of Next Generation Public Safety User Interfaces
- The project addresses Goal 2 of the NIST Public Safety Innovation Accelerator Program – User Interface (PSIAP-UI): Research on the Effectiveness and Transferability of AR/VR Simulations.
- Enabled by FirstNet: new era of crisis management
  - Interoperable high-speed broadband LTE network
  - Handle critical situations that goes beyond a common voice communication channel
- First responders will have the opportunity to:
  - Learn the precise location of indoor and outdoor points of interest
  - Receive real-time data analytics that are relevant to the mission
  - Have assurances for clear and reliable mission critical voice communications

Project Motivation

- The reality of public safety involves complex scenarios with many factors at play
- PSOs equipment and interfaces are not currently designed to take advantage from the possibilities enabled by FirstNet
- Effective interactions need to be developed into novel systems operated by first responders
- These technologies need to help the first responders to solve their real problem and not add another layer of complexity in their workflow.

Project Goals

To design, prototype and evaluate user interfaces for the next generation public safety ecosystem and its first responders.

For three main disciplines

Emergency Medical Services

Law Enforcement

Fire Fighting

Project Goals

To design, prototype and evaluate user interfaces for the next generation public safety ecosystem and its first responders.

How?

User-centered approach that can make the deployment and adoption of next-generation user interfaces reflect the first responders requirements and contexts of use.

Project Goals

To design, prototype and evaluate user interfaces for the next generation public safety ecosystem and its first responders.

How?

- Partner with local PSOs in order to fully understand the needs and expectations of first responders
  - First responders contribute through their feedback and experience
- Immersive Virtual Reality (VR) as a simulation platform to evaluate UI designs.
  - Through VR, we can achieve high levels of realism with computer simulation.
  - There are no risks to the user
  - Simulations can be repeated and tweaked as many times as necessary with little effort

Projected Outcomes

The final outcome of the project will have a transformative impact on all public safety disciplines by offering a collection of user interfaces that have been demonstrated to be effective and efficient in the context of each PSO specific requirements.

When technology becomes available, the designed PSUIs will be instrumental for the adoption of next generation user interfaces by the public safety community.

Project Overview

11/2018 - 05/2019

Requirement analysis

06/2019 - 12/2019

Prototyping and evaluation of interaction techniques for PSOs

01/2020 - 02/2021

Prototyping and evaluation of comprehensive PSUIs

03/2021 - 06/2021

Prototyping and evaluation of a cross-discipline PSUIs

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Prototyping and evaluation of comprehensive PSUIs

03/2021 - 06/2021

Prototyping and evaluation of a cross-discipline PSUIs

Close **observation** and **documentation** of the culture at each of the PSOs

Participatory Design: meetings and interviews, training observation, shadow operations

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Project Overview

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01/2020 - 02/2021

Prototyping and evaluation of comprehensive PSUIs

03/2021 - 06/2021

Prototyping and evaluation of a cross-discipline PSUIs

Travel, **selection and manipulation** tasks in VEs in the context of identified critical elements for each public safety disciplines

The main goal of this phase is to establish what techniques are most efficient

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Project Overview

Combine most effective interaction techniques with cognitive aids for enhanced situational awareness and wayfinding

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Project Overview

Leverage the interfaces designed in the previous phases into simulation of a critical situation that needs a response from Fire, EMS and Law Enforcement

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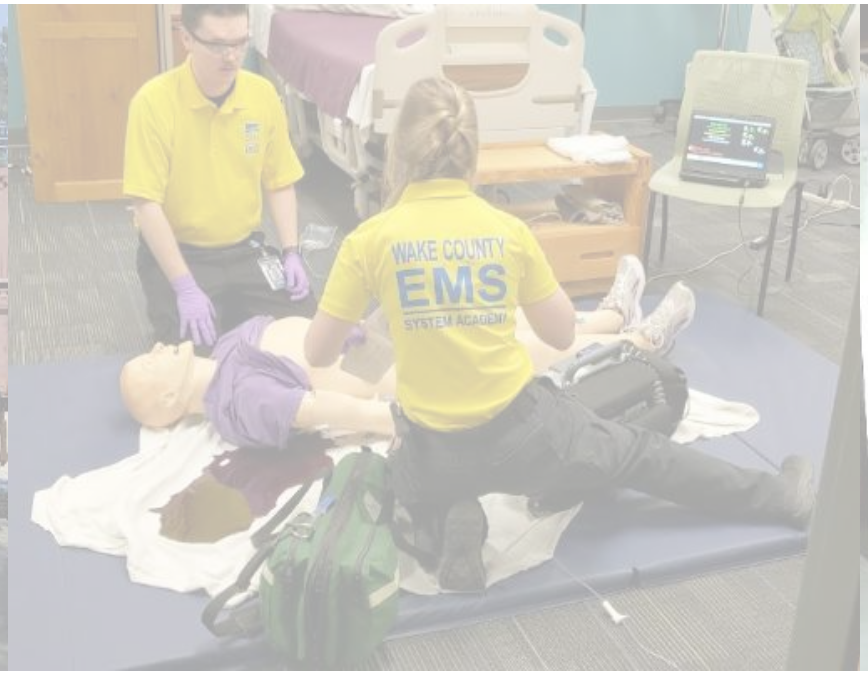


Requirement Analysis

Requirement Analysis

Methodology - PSOs

- Since each public safety discipline has unique requirements and protocols, we have partnered with three PSOs:

Wake County EMS

Hillsborough Police Department

Durham Fire Department

- Through participatory design, these PSOs helped us understand their processes and find opportunities for the design of next generation user interfaces
- Formative feedback on initial UI prototypes.

Requirement Analysis

Methodology - Phases

Information Gathering

Meetings
Interviews
Training observation
Ride-alongs

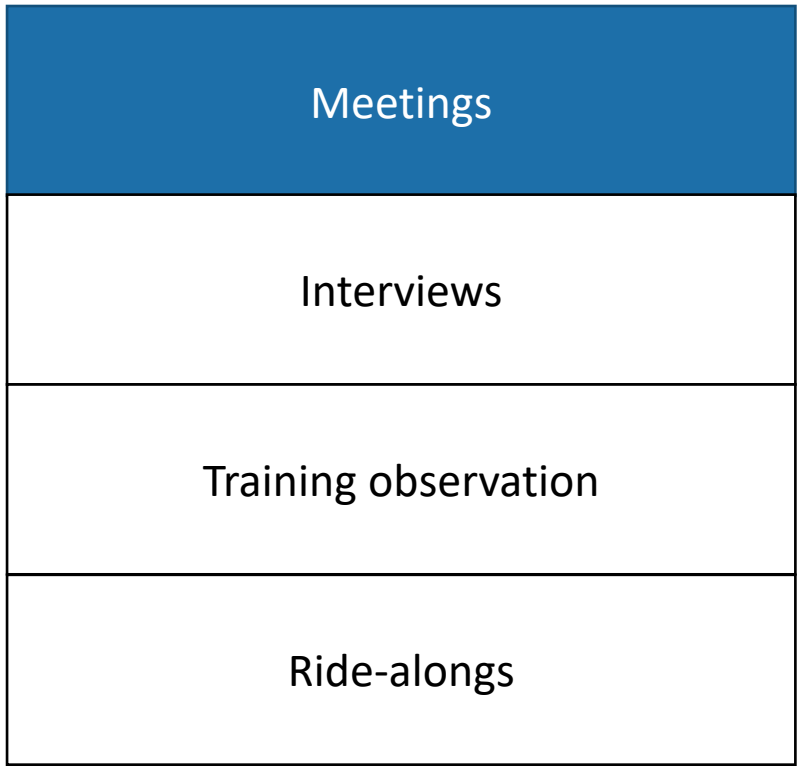
Design and Prototyping of UIs

Data analysis
Research team brainstorming
User interface designs
Group discussions
Prototype refinement

Requirement Analysis

Methodology - Phases

Information Gathering

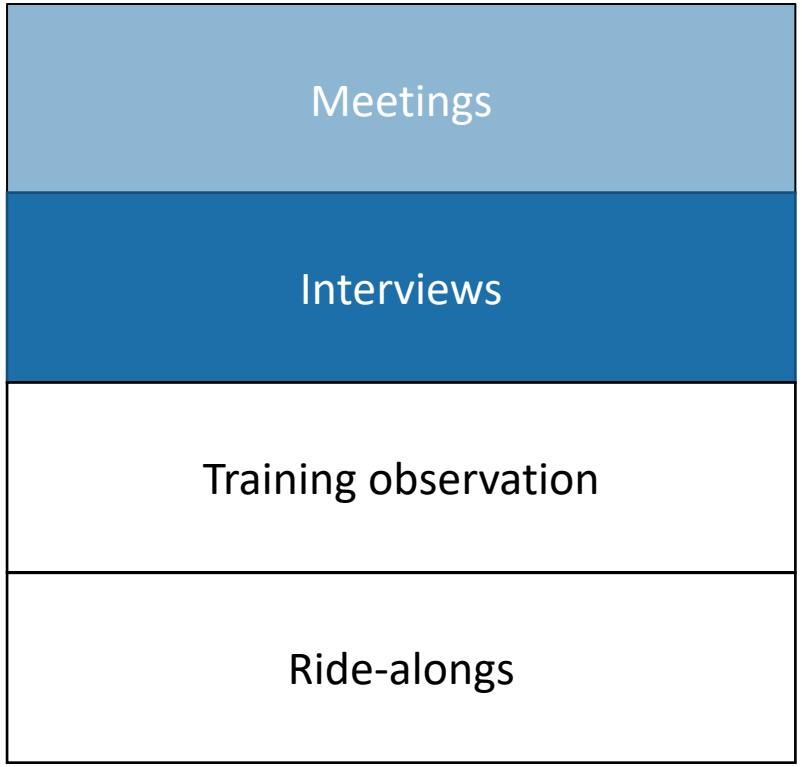


- Meeting with PSO Chiefs
  - Project presentation
  - Plan for interviews and training observations
  - Assignment of core group of first responders (4-6 people)
- Meeting with the core group
  - Project presentation
  - Approach to accomplish the objectives
  - First responders roles in the project
  - Q&A

Requirement Analysis

Methodology - Phases

Information Gathering



- 1-1 Interviews with first responders of the core group.
- Demographic questionnaire
- Semi-structured interviews
- Interview questions based on the “Voice of First Responders” (Dawkins et al. 2018)
  - Emphasis on the technology that they think would be helpful in their context
- IRB protocol for interviews

Requirement Analysis

Methodology - Phases

Information Gathering

- Meetings
- Interviews
- Training observation
- Ride-alongs

Firefighters
Search and Rescue training in a burning building

EMS
Gunshot wound trauma

Law Enforcement
Search for suspicious subjects inside a house

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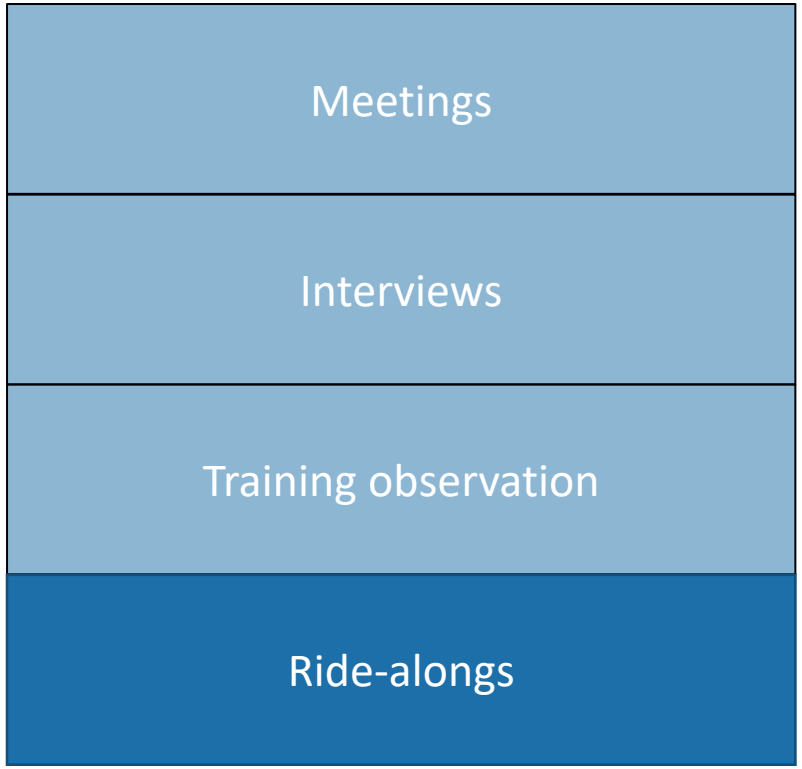
Requirement Analysis

Methodology - Phases

Information Gathering

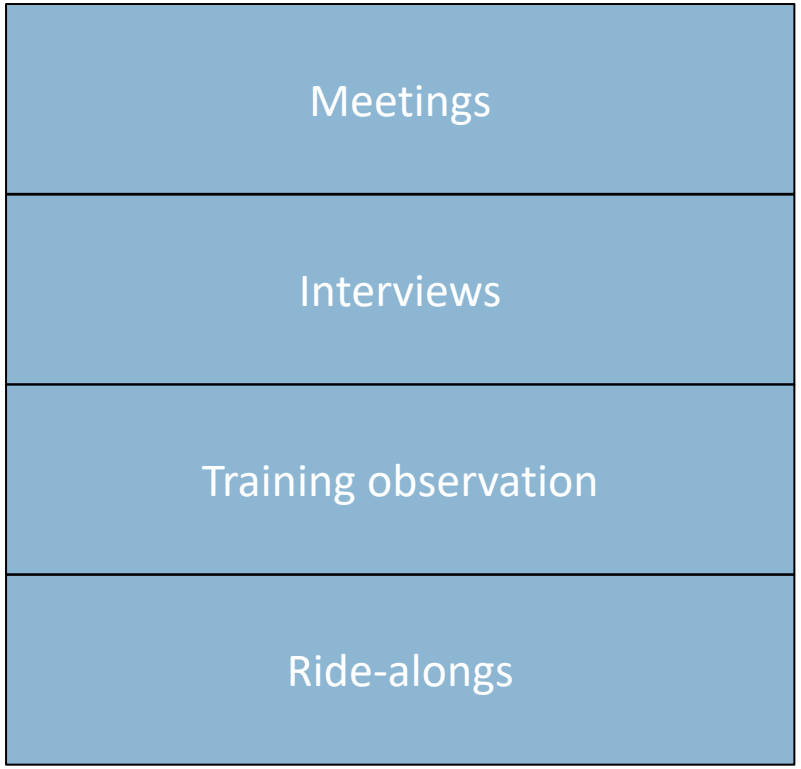


- Capture first responders' procedures and environmental conditions
- Equipment and devices used
- Difficulties with the use of current technology

Requirement Analysis

Methodology - Phases

Information Gathering



Requirement Analysis

Methodology - Phases

Information Gathering

- Meetings
- Interviews
- Training observation
- Ride-alongs

Design and Prototyping of UIs

- Data analysis
- Research team brainstorming
- User interface designs
- Group discussions
- Prototype refinement

Requirement Analysis

Methodology - Phases

Design and Prototyping of UIs

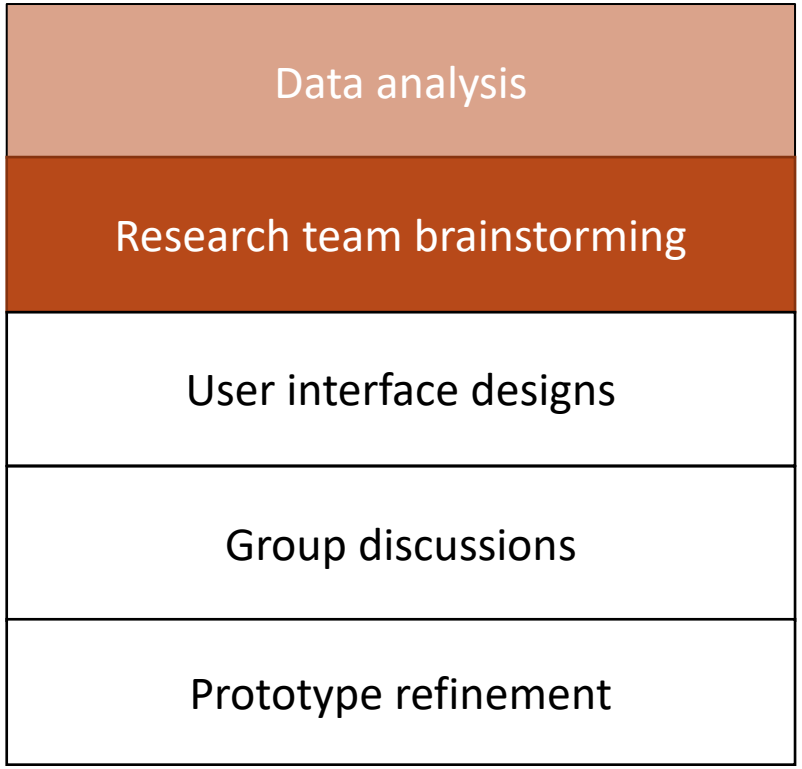
Data analysis
Research team brainstorming
User interface designs
Group discussions
Prototype refinement

- Tabulate the demographic data
- Speech-to-text transcription of interview recordings
  - IBM Watson (70%-98% confidence)
  - Human revision
- Text analysis tools
  - Terms frequency
  - Word cloud

Requirement Analysis

Methodology - Phases

Design and Prototyping of UIs

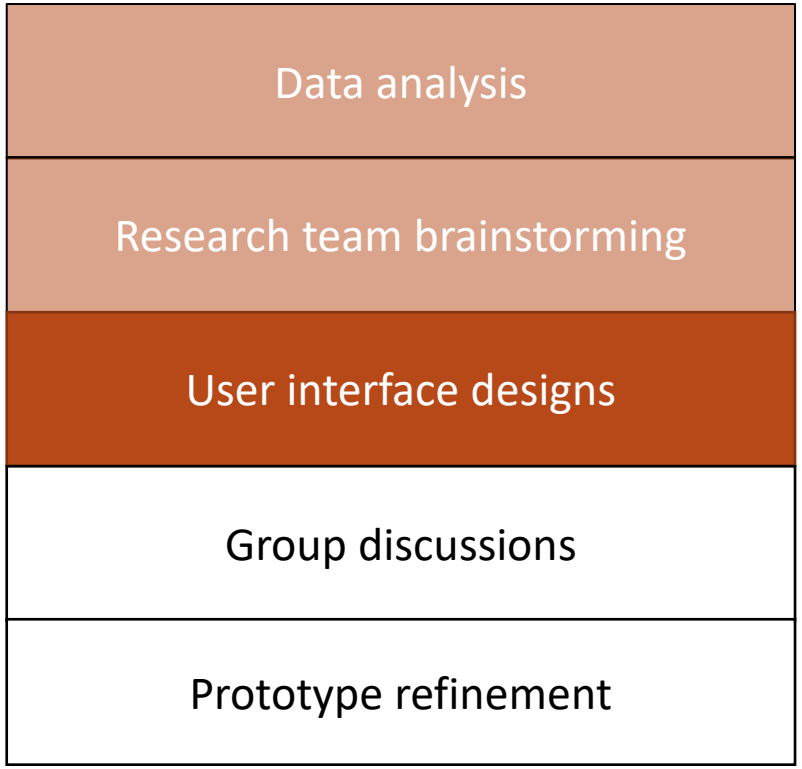


- Scenario selection
- Key role identification
- Task identification
- Next-generation UI to support identified task

Requirement Analysis

Methodology - Phases

Design and Prototyping of UIs

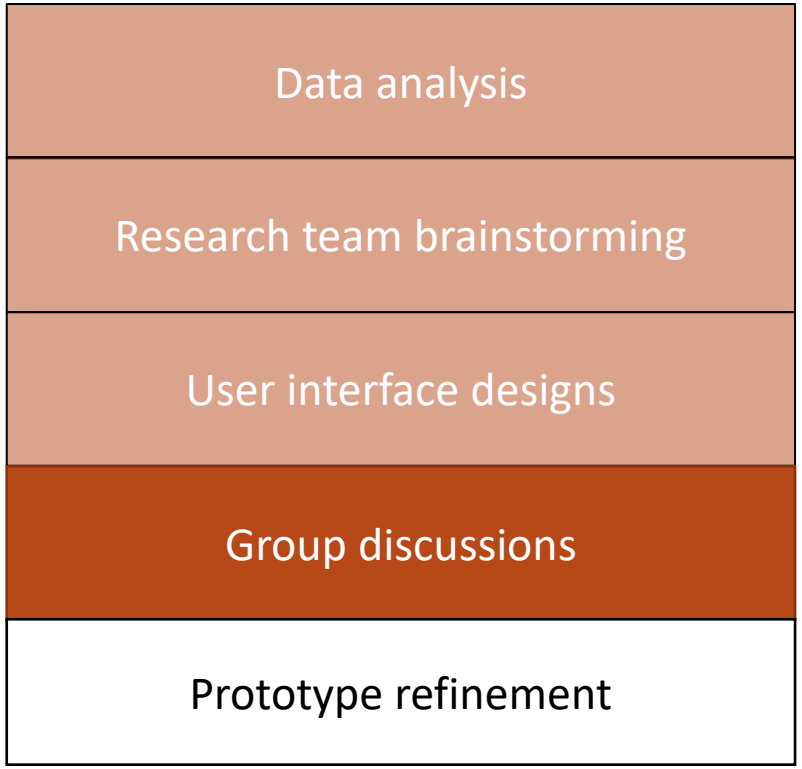


- Each PSO has their own needs
- Display technology
  - HUD, Handheld, arm-mounted,…
- Interactions
  - Gestures, buttons, eye-gaze, haptics,…
- Information
  - Patient data, criminal background, risk assessment, general situational awareness,…

Requirement Analysis

Methodology - Phases

Design and Prototyping of UIs

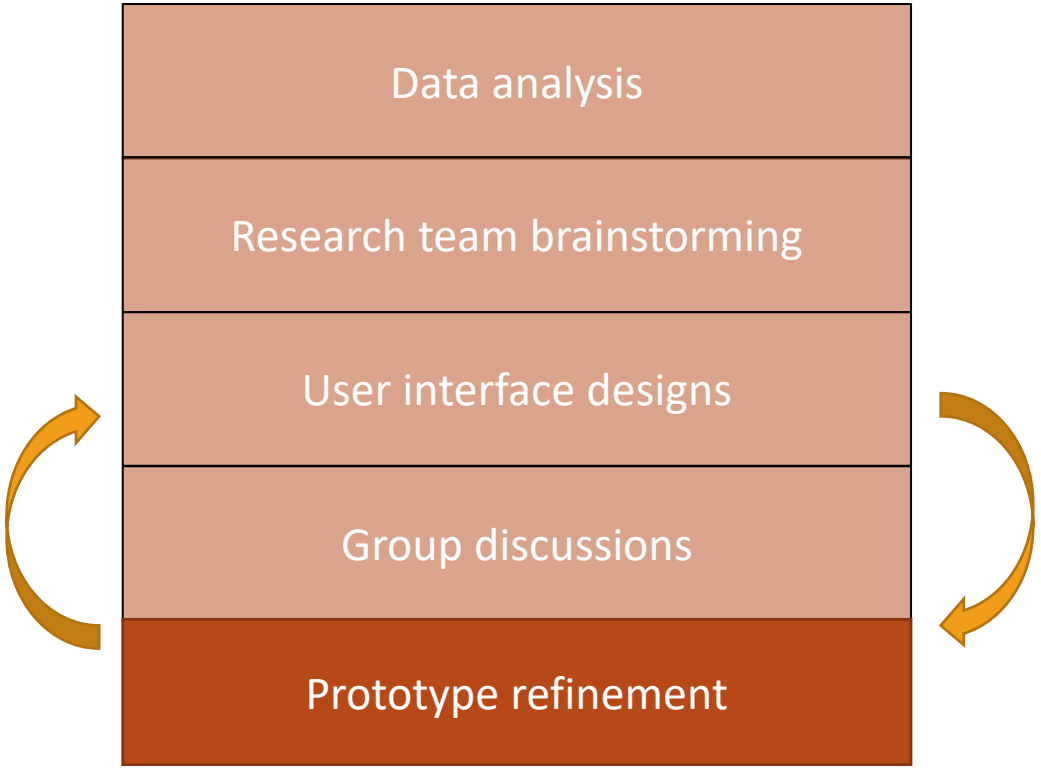


- Re-engage with first responders' core group
- Present the chosen scenario
- Introduce the UI elements through a use case narrative
- Discuss UI designs
- Collect feedback

Requirement Analysis

Methodology - Phases

Design and Prototyping of UIs

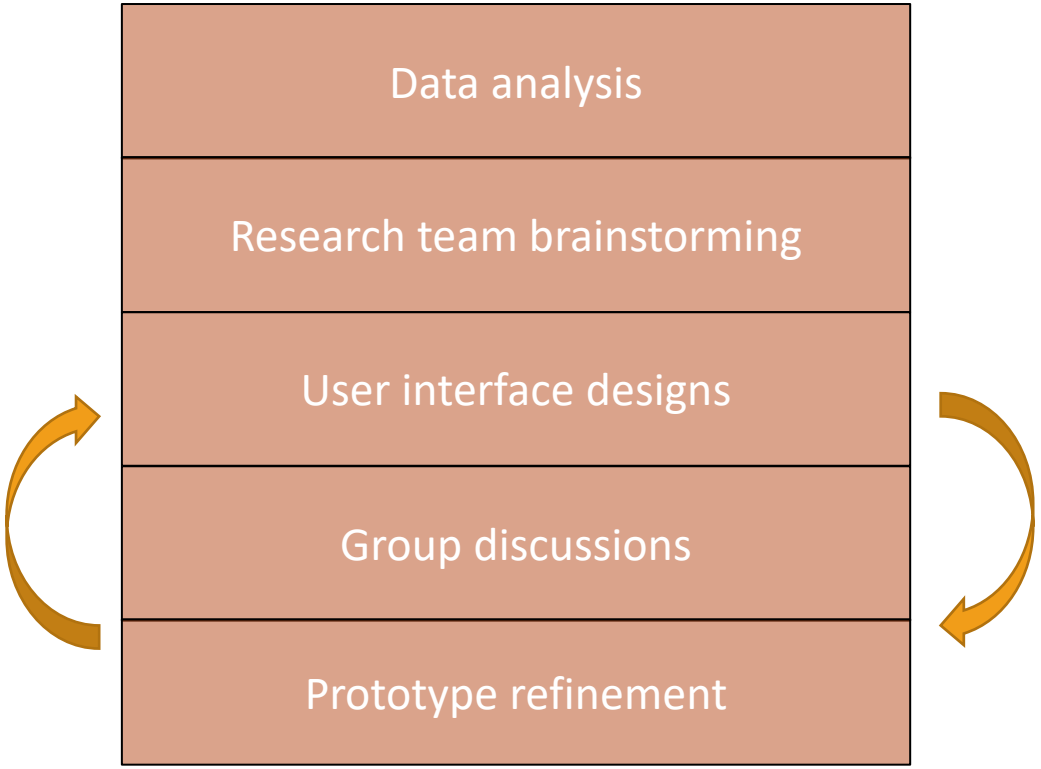


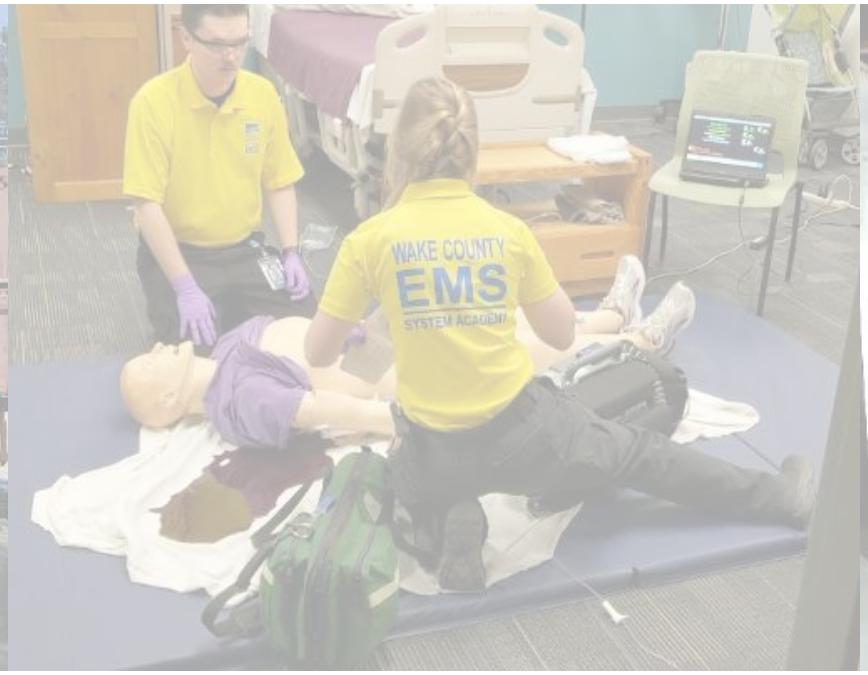
- Analyze audio recordings of the group meetings
- Identify points that need improvement
- Refine interactions and interfaces
- Add new elements for a second group discussion

Requirement Analysis

Methodology - Phases

Design and Prototyping of UIs





Requirement Analysis

Results

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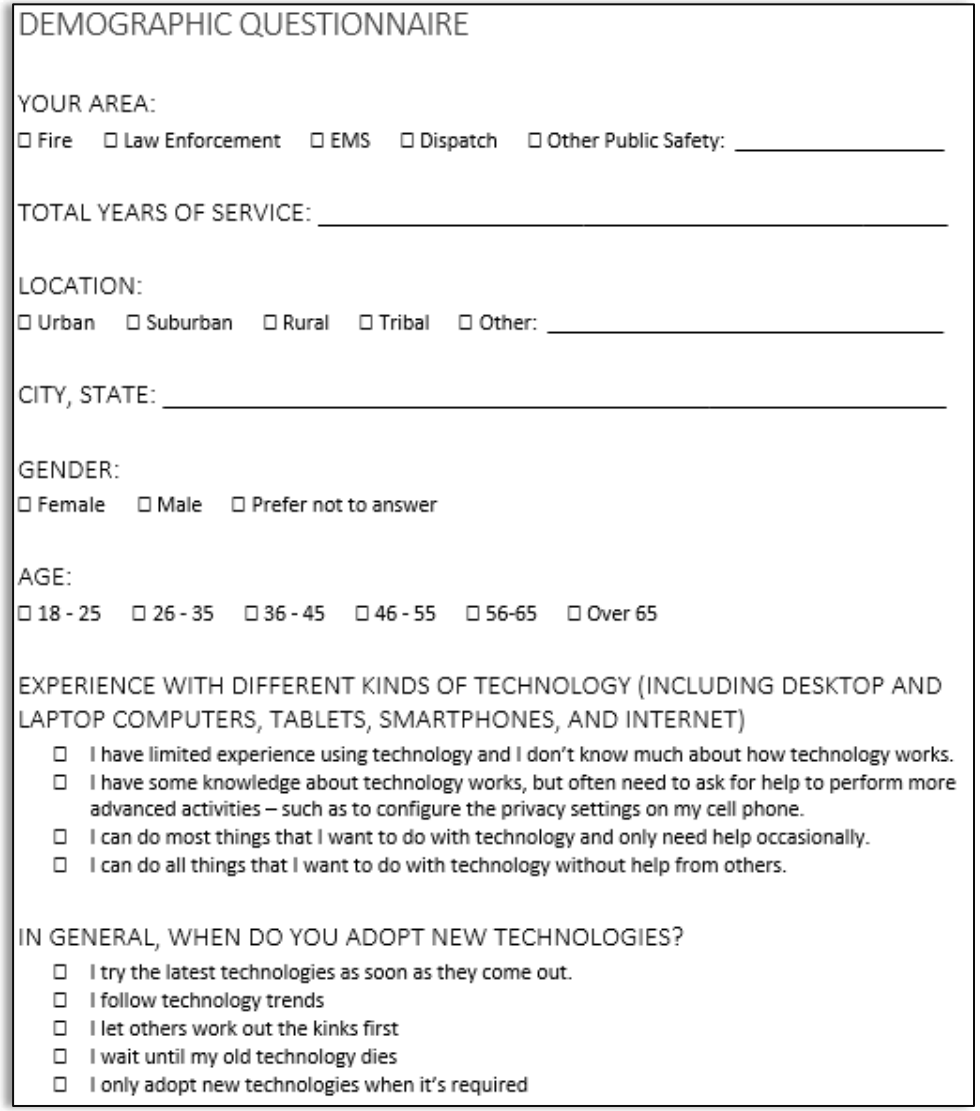
Requirement Analysis

Results – 1-1 Interviews

Demographics Questionnaire

- 13 first responders interviewed (2 female)
  - Durham Fire: 4
  - Wake County EMS: 5
  - Hillsborough Police: 4
- Years of service average: *M=18 (SD=8.11)*
  - One first responder with only 2 years of service
- 100% work at urban area
  - 4 also work in suburban area
  - 3 also work in rural area
- Experience with tech (1-4): *M=2.7 (SD=0.69)*
- Willingness to adopt new tech (1-5): *M=3 (SD=1.03)*



DEMOGRAPHIC QUESTIONNAIRE

YOUR AREA:

☐ Fire ☐ Law Enforcement ☐ EMS ☐ Dispatch ☐ Other Public Safety: _____

TOTAL YEARS OF SERVICE: _____

LOCATION:

☐ Urban ☐ Suburban ☐ Rural ☐ Tribal ☐ Other: _____

CITY, STATE: _____

GENDER:

☐ Female ☐ Male ☐ Prefer not to answer

AGE:

☐ 18 - 25 ☐ 26 - 35 ☐ 36 - 45 ☐ 46 - 55 ☐ 56-65 ☐ Over 65

EXPERIENCE WITH DIFFERENT KINDS OF TECHNOLOGY (INCLUDING DESKTOP AND LAPTOP COMPUTERS, TABLETS, SMARTPHONES, AND INTERNET)

- ☐ I have limited experience using technology and I don't know much about how technology works.
- ☐ I have some knowledge about technology works, but often need to ask for help to perform more advanced activities – such as to configure the privacy settings on my cell phone.
- ☐ I can do most things that I want to do with technology and only need help occasionally.
- ☐ I can do all things that I want to do with technology without help from others.

IN GENERAL, WHEN DO YOU ADOPT NEW TECHNOLOGIES?

- ☐ I try the latest technologies as soon as they come out.
- ☐ I follow technology trends
- ☐ I let others work out the kinks first
- ☐ I wait until my old technology dies
- ☐ I only adopt new technologies when it's required

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Requirement Analysis
Results – 1-1 Interviews

Semi-structured Interviews

- ~6h of recordings (~25 minutes each interview)
- Audio to text transcripts: IBM Watson Text to Speech
  - Good accuracy, but need an extra revision step
  - Allows for text analysis
- Identification of possible use-case scenarios
- Identification of desired user interfaces

INTERVIEW QUESTIONS

CONTEXT AND BELIEFS OF WORK

WHAT IS YOUR JOB TITLE?

- If you were describing your job to someone who knew nothing about it (like to a kid, or someone from another planet), how would you describe it?
- Tell me about your daily routine. How does your day begin?
  - If there isn't one, list the different kinds of things you do during the day.
  - What's typical communication like for you during your work day?
- What is it like when you are at the station?
  - Describe your relationship with other folks you work with.
  - Tell me about the community you serve.
- What is it like when you are at the work but outside of the station?

COMMUNICATION AND TECHNOLOGY

LIST THE DIFFERENT KINDS OF TECHNOLOGY (DEVICES, EQUIPMENT) YOU USE TO DO YOUR JOB.

- How would you describe the technology/equipment you currently use?
- Are there apps that you use to do your job?
- Have there been times when the technology has gotten in the way?

HOW (IF AT ALL) HAVE THINGS CHANGED IN TERMS OF COMMUNICATION SINCE YOU BECAME A FIRST RESPONDER?

- Do these changes make communication better or worse for you?

IN A TYPICAL DAY ON YOUR JOB, WHAT KINDS OF INFORMATION DO YOU NEED?

- Are there other kinds of information you need for situation that aren't so typical – and if so, what is it?

IF YOU THINK ABOUT THE INCIDENTS YOU'VE RESPONDED TO OVER THE LAST FEW WEEKS OR MONTHS, IS THERE INFORMATION THAT COULD HAVE HELPED YOU UNDERSTAND THE SCENE BEFORE YOU GOT THERE? TELL ME ABOUT IT.

- What kind of information would be most helpful, either for typical or for more complicated calls?
- How would you want to get that information?

WHAT, IF ANYTHING, DO YOU THINK CAUSES COMMUNICATION PROBLEMS IN YOUR WORK?

- What, if anything, could help with these problems?

LET'S TALK OUT OF THE BOX FOR A MINUTE, DESCRIBE YOUR TECHNOLOGY WISH LIST: PIE IN THE SKY HERE, IF TECHNOLOGY COULD DO WHATEVER YOU WANTED IT TO, WHAT WOULD YOU WANT?

- Are there new or different apps you can think of that could be useful?

IS THERE ANYTHING ELSE YOU'D LIKE TO SHARE ABOUT YOUR JOB THAT YOU THINK IS IMPORTANT FOR US TO KNOW?

DO YOU HAVE ANY QUESTIONS FOR ME/US?

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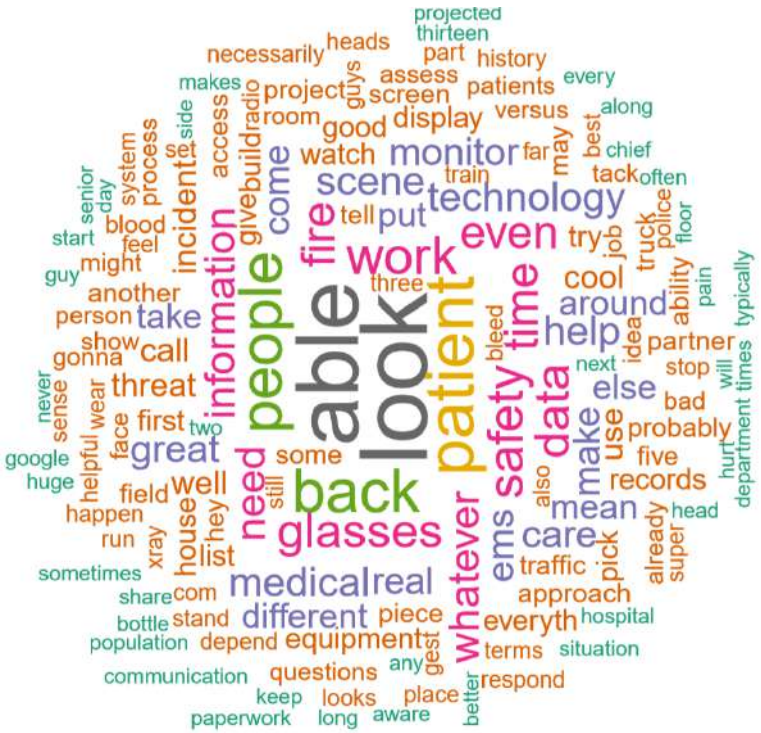
Requirement Analysis

Results – Text Analysis

Requirement Analysis

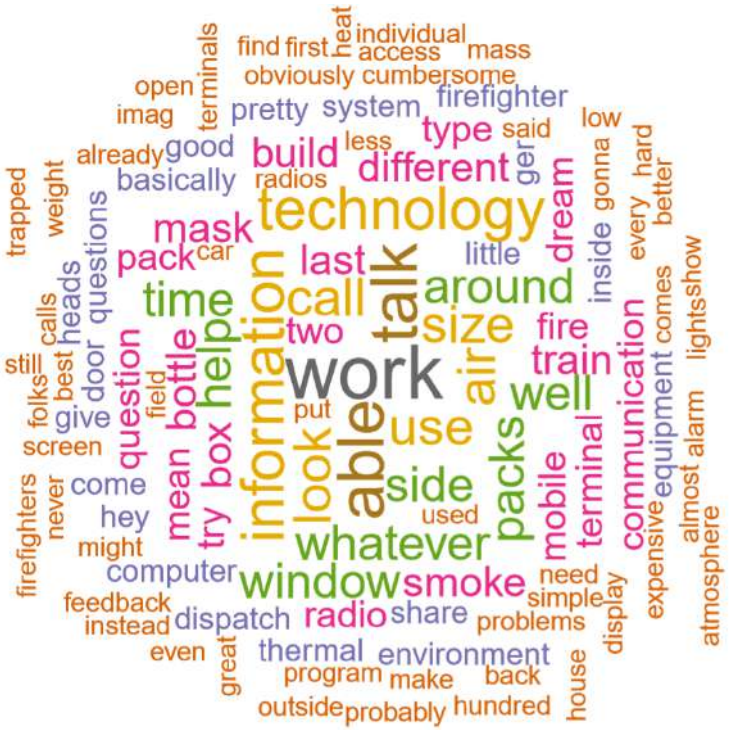
Results – Text Analysis for each PSO

EMS



LE

FF



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Activities done with PSOs

Emergency Medical Services

- 1-on-1 Interviews: 5
- Training observations: 2
- Group discussions: 2

Law Enforcement

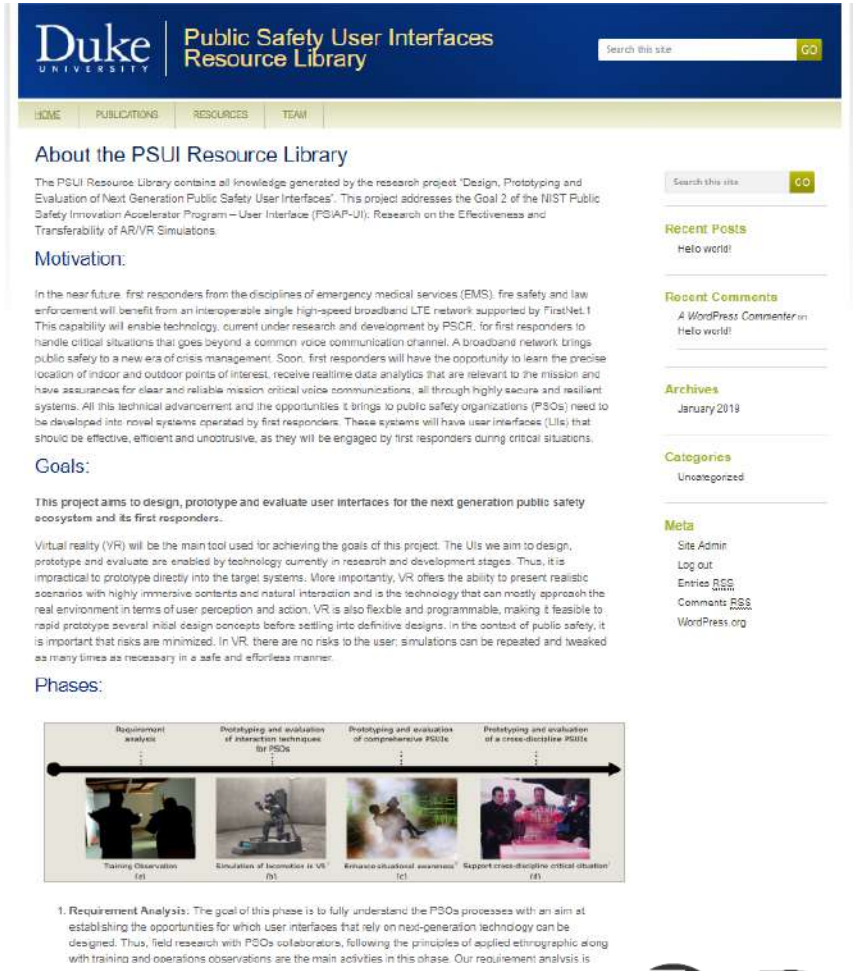
- 1-on-1 Interviews: 4
- Training observations: 1
- Group discussions:2
- Ride-alongs: 1

Firefighters

- 1-on-1 Interviews: 4
- Training observations: 1
- Group discussions: 2

Public Safety User Interfaces Resource Library

- https://sites.duke.edu/psui/
- The knowledge generated by this project will be maintained and made available to the public.
- PSOs around the country and industry providers will be able to leverage the materials and methods used in the design, prototyping and evaluation of next generation user interfaces.



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Next Steps

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Design, Prototyping and Evaluation of Next Generation Public Safety User Interfaces

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Mark Ogren – mark.ogren@duke.edu

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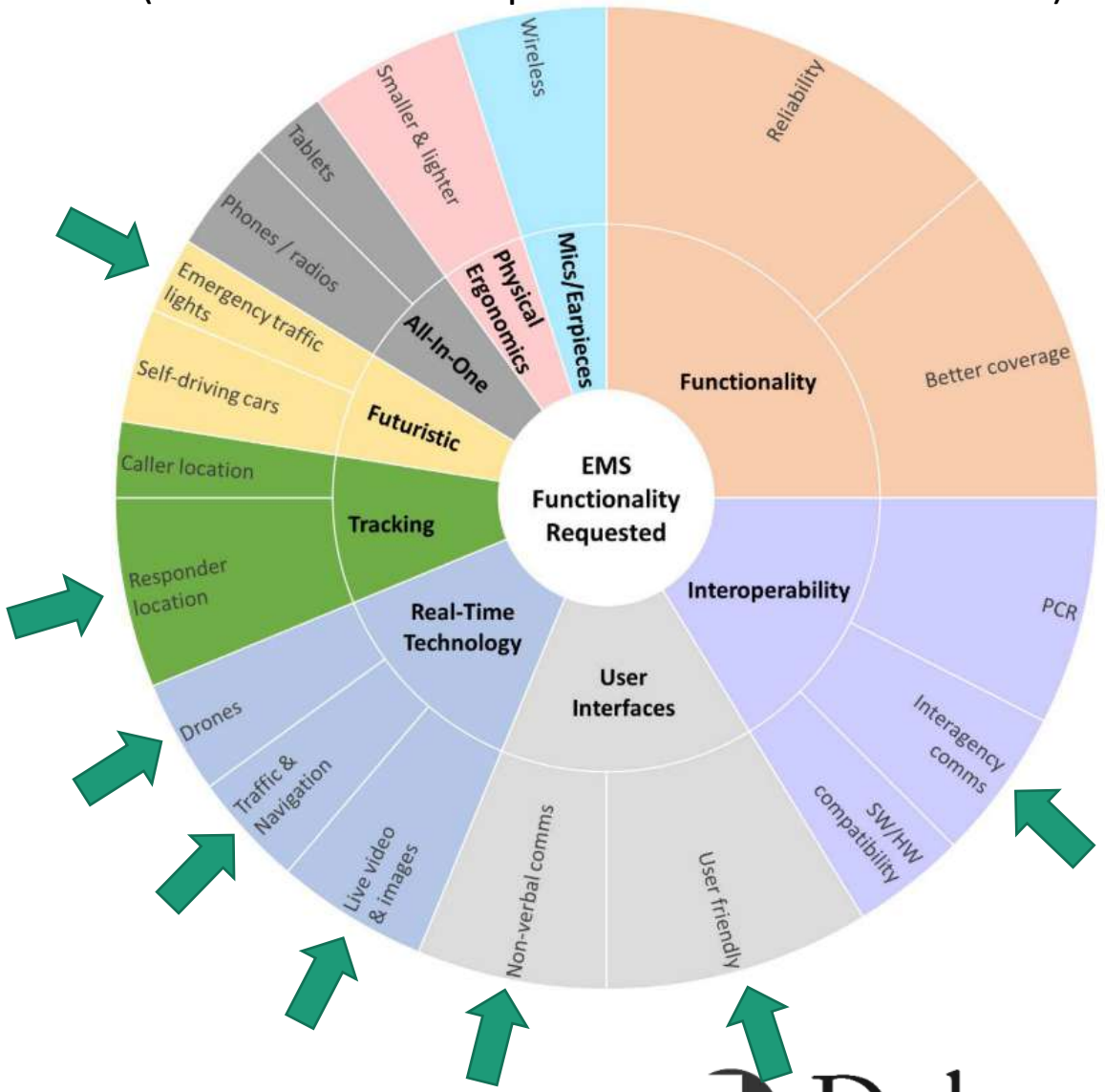
Requirement Analysis - EMS
Functionality Requested

- “Trauma glasses”: body scanner for injuries, patient vital info
- Safety: discrete way to communicate with the partner to inform a dangerous situation while assessing the patient
- Real time traffic
- Better way to communicate with other PSOs
- Information about the patient: medical history, allergies,…–fast assessment
- Equipment portability

(“Voices of First Responders” Dawkins et al. 2018)



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Requirement Analysis - EMS

1st Chosen Scenario: Gunshot Wound to Upper Chest

Scenario	Gunshot Wound to Upper Chest
Key Role	EMS Paramedic
Task to simulate	Assess a trauma patient, control bleeding

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Requirement Analysis - EMS

1st Chosen Scenario: Gunshot Wound to Upper Chest

Issues identified with first responders

- 10-minute window
- Removal to hospital ASAP
- Limited Assessment

Requirement Analysis - EMS

1st Chosen Scenario: Gunshot Wound to Upper Chest

Issues identified with first responders

- 10-minute window
- Removal to hospital ASAP
- Limited Assessment

Better scenario: first responder on scene for an extended period of time

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Requirement Analysis - EMS

2nd Chosen Scenario: Complicated Medical Call

Scenario	65-year-old burned while cooking at home
Key Role	EMS Paramedic
Task to simulate	Assess the patient, identify how much of the patient's body is burned, decide if the burn is considered critical, initial burn care, control bleeding and other injuries due to the fall, notify the medical center

[Patient Data]

Name: John Doe
Age : 30

[Allergies]

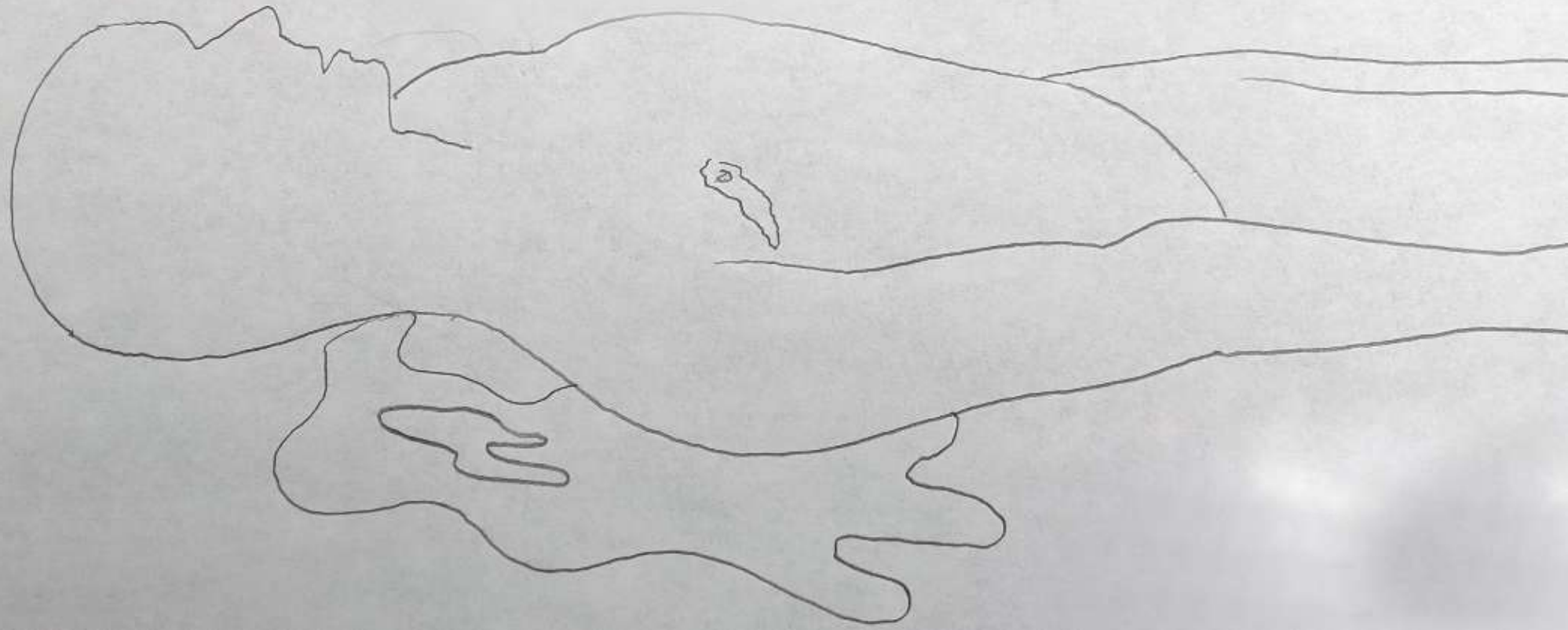
Sulfa
NSAIDS

[Tool Location]
Green Bag

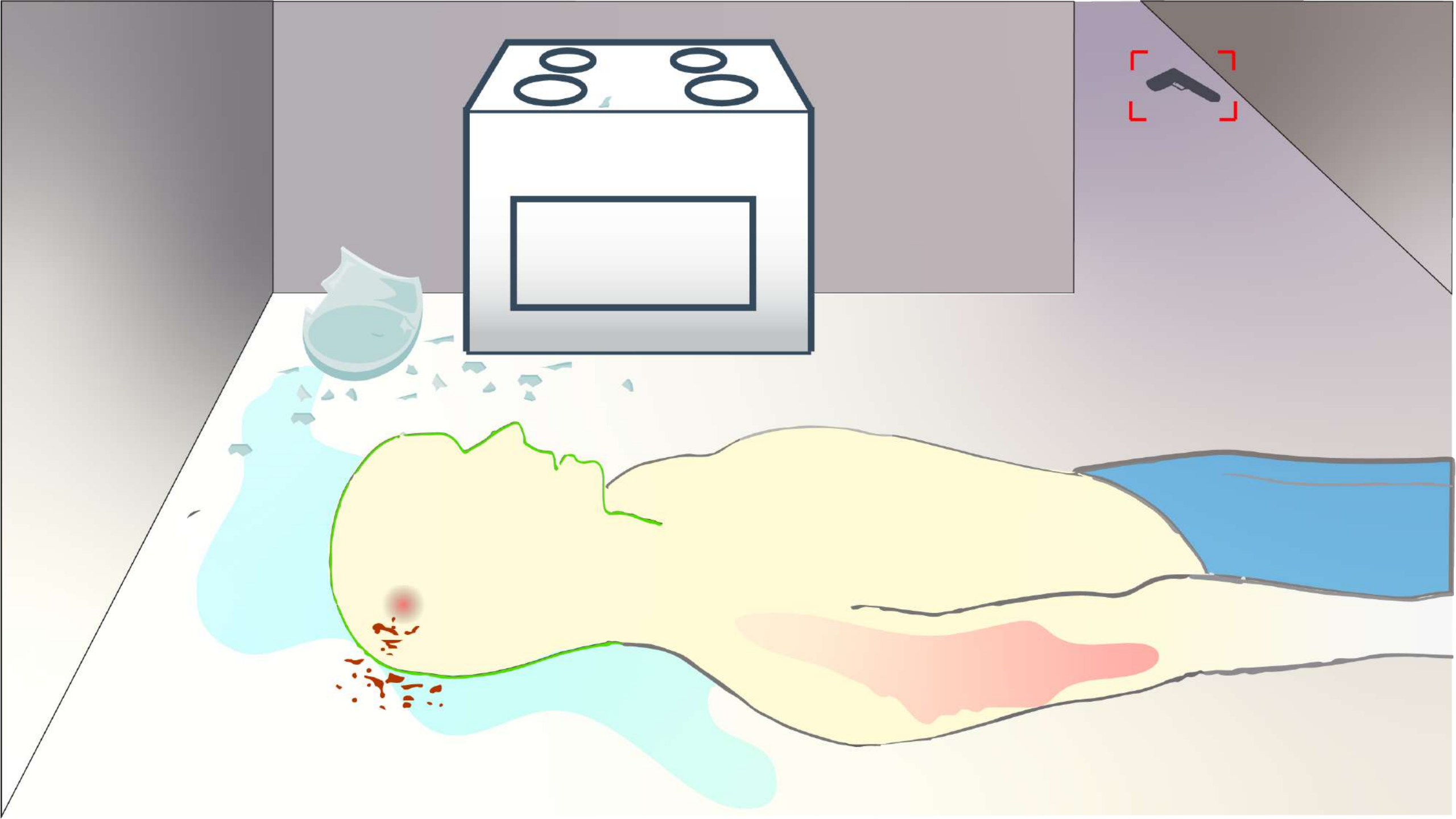
[Trauma]
Gun-shot

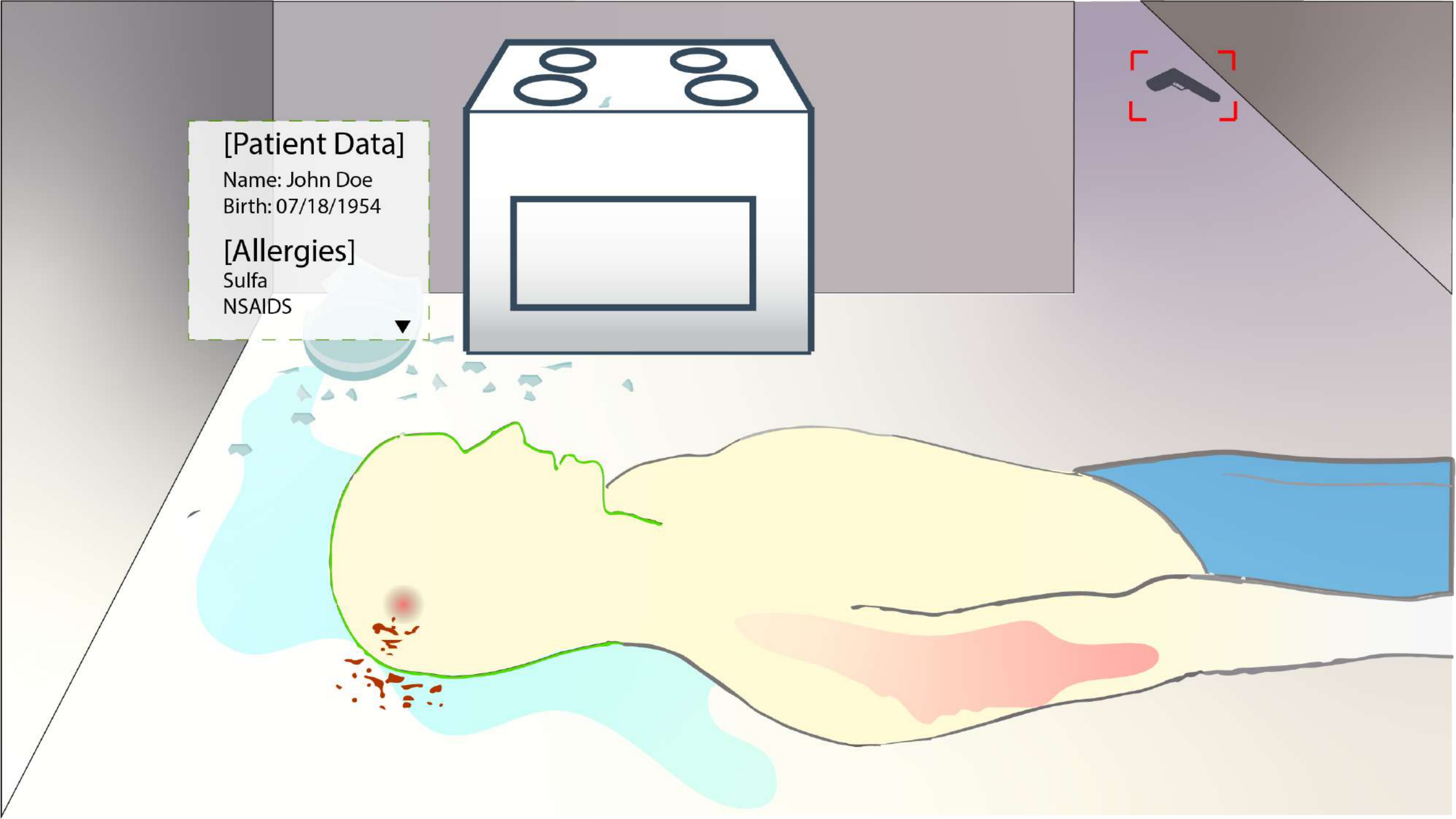
[Center]
UNC

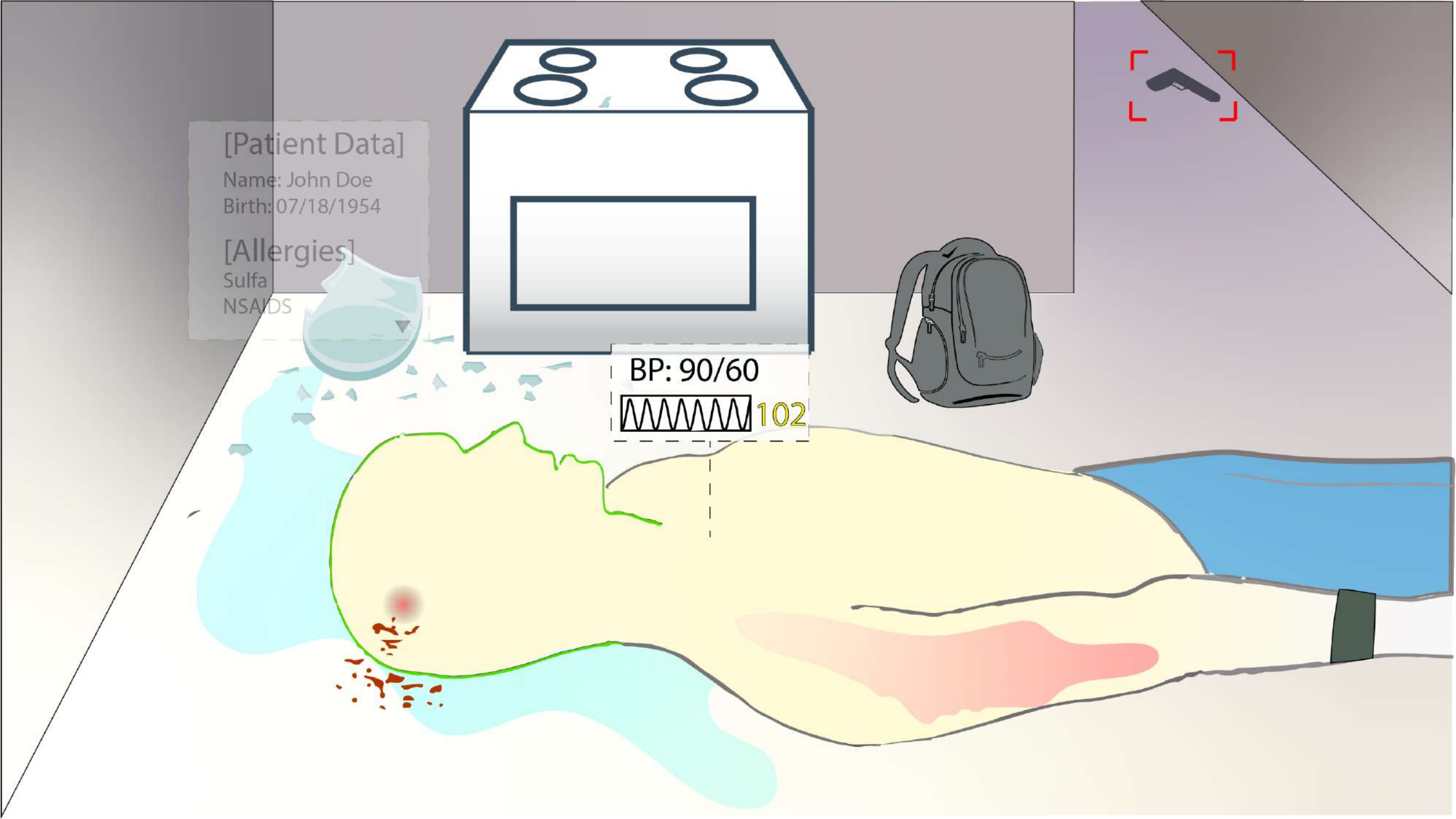
BP-120/80
HR-75

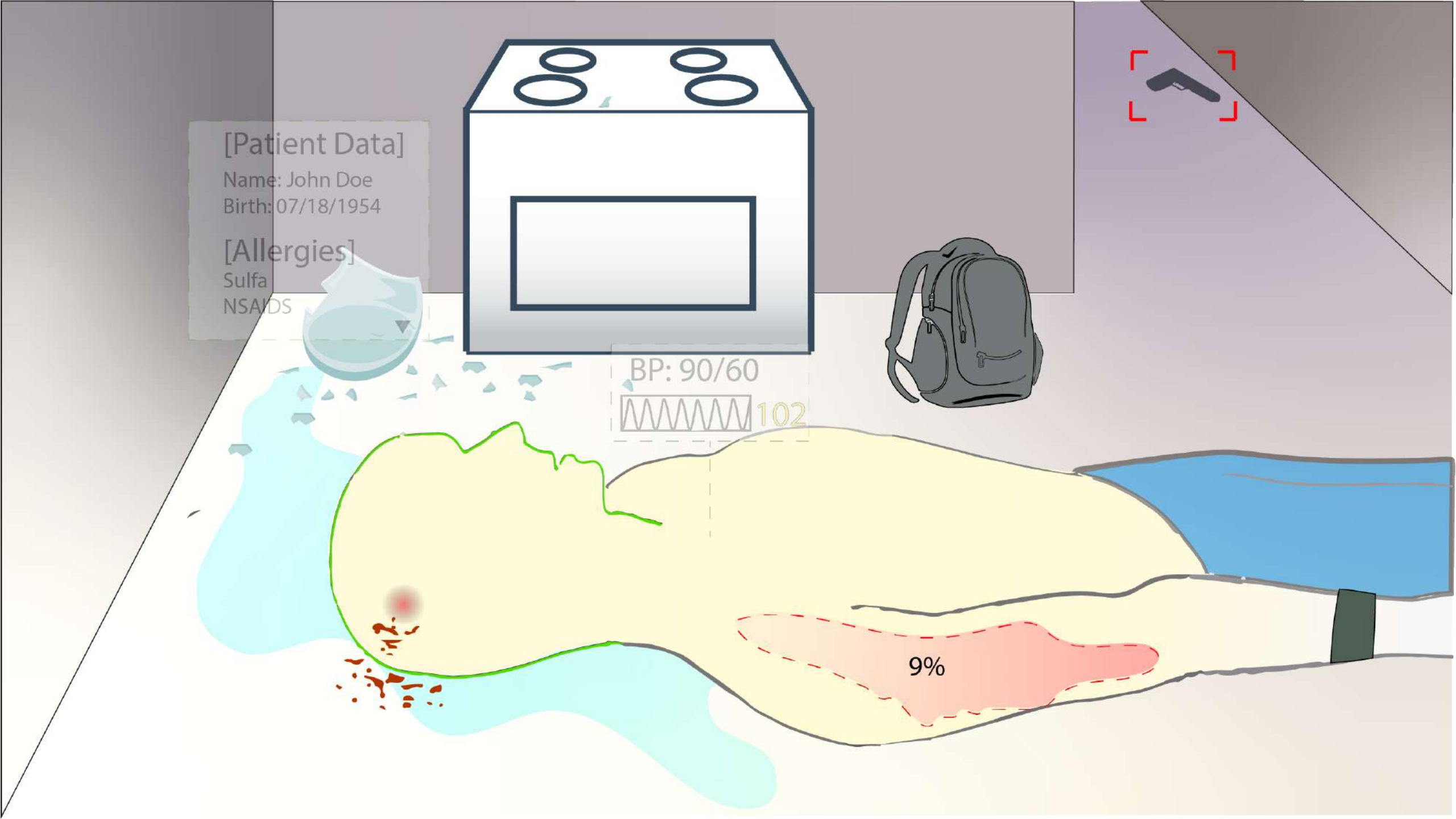


DANGER



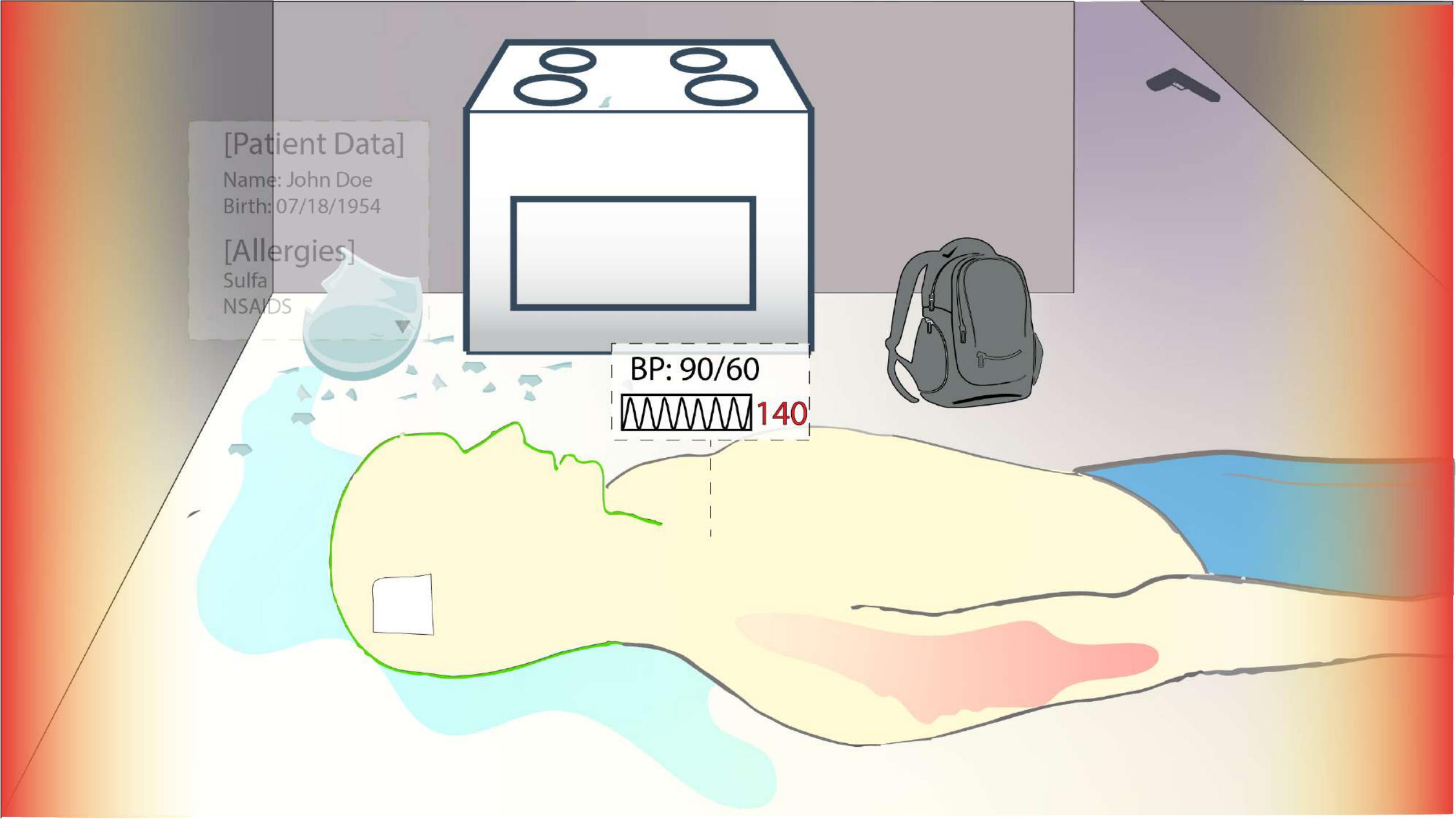

[Patient Data]
Name: John Doe
Birth: 07/18/1954
[Allergies]
Sulfa
NSAIDS


[Patient Data]
Name: John Doe
Birth: 07/18/1954
[Allergies]
Sulfa
NSAIDS
BP: 90/60
102


[Patient Data]
Name: John Doe
Birth: 07/18/1954
[Allergies]
Sulfa
NSAIDS
BP: 90/60
102
9%


[Patient Data]
Name: John Doe
Birth: 07/18/1954
[Allergies]
Sulfa
NSAIDS
BP: 90/60
102
[Medical]
Arm, Chest burn: 9%
Blood lost: 300ml
[Center]
UNC Hospital
[Check List]
Alert Hospital
Control Bleeding
Burn Care
Pain killer (5 mins)

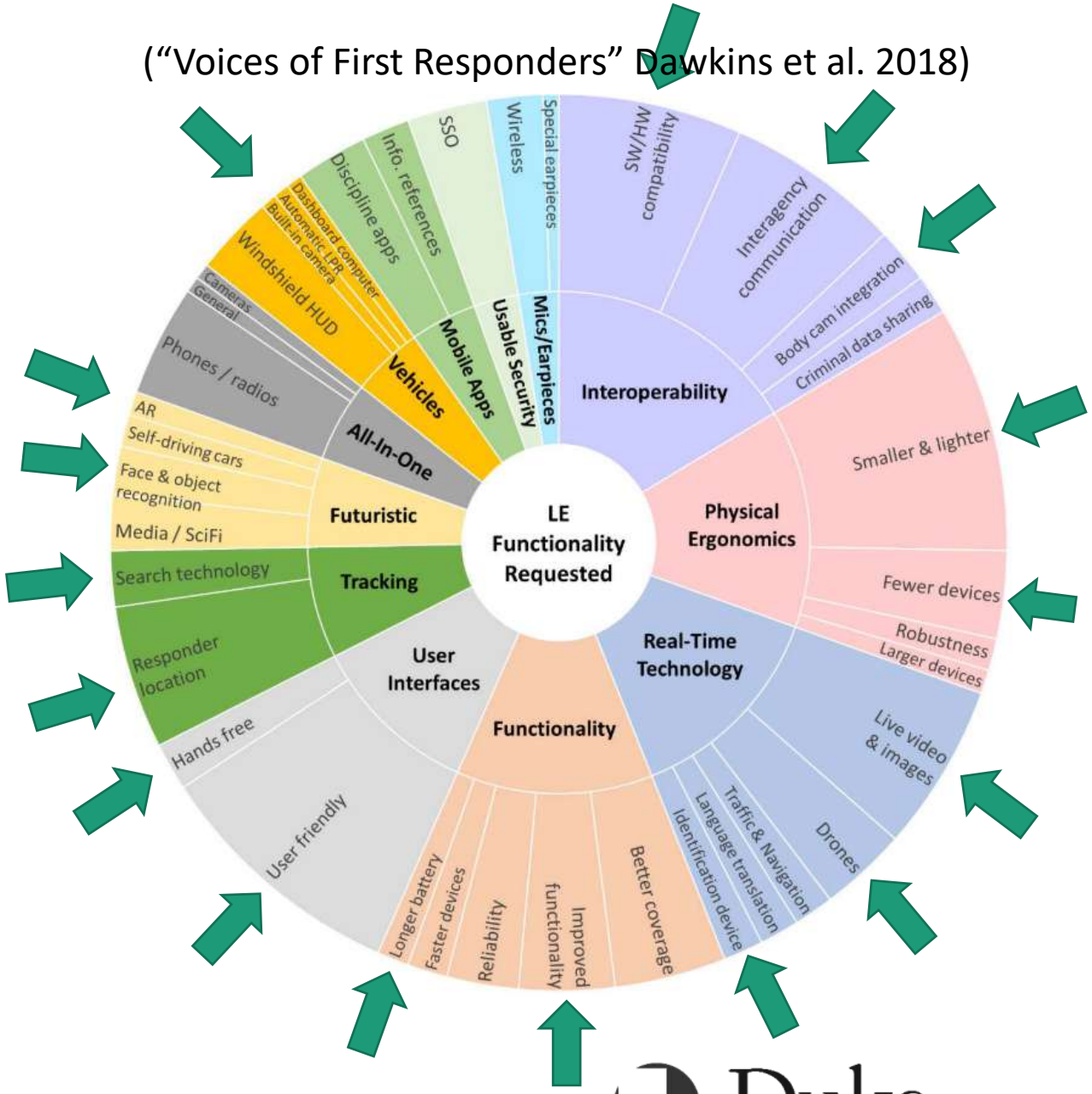

[Patient Data]
Name: John Doe
Birth: 07/18/1954
[Allergies]
Sulfa
NSAIDS
BP: 90/60
102


[Patient Data]
Name: John Doe
Birth: 07/18/1954
[Allergies]
Sulfa
NSAIDS
BP: 90/60
140

Requirement Analysis - LE
Functionality Requested

- Body scanner: face recognition, detect gun, danger
- Better communications: instant communication, clear voices, 1-1 and group
- Information about indoor spaces: pinpoint info in maps
- Information without the need to go back to the vehicle to use the computer
- Alarm is tapping
- Arm display
- Easy access to information: Interface that integrates multiple databases

("Voices of First Responders" Dawkins et al. 2018)



Requirement Analysis - LE

Chosen Scenario: Traffic stop

Scenario	Traffic stop
Key Role	Police officer who’s on duty patrolling the streets
Task to simulate	Execute the traffic stop, assess the vehicle and the occupants, Proceed with warning, ticket or severe actions

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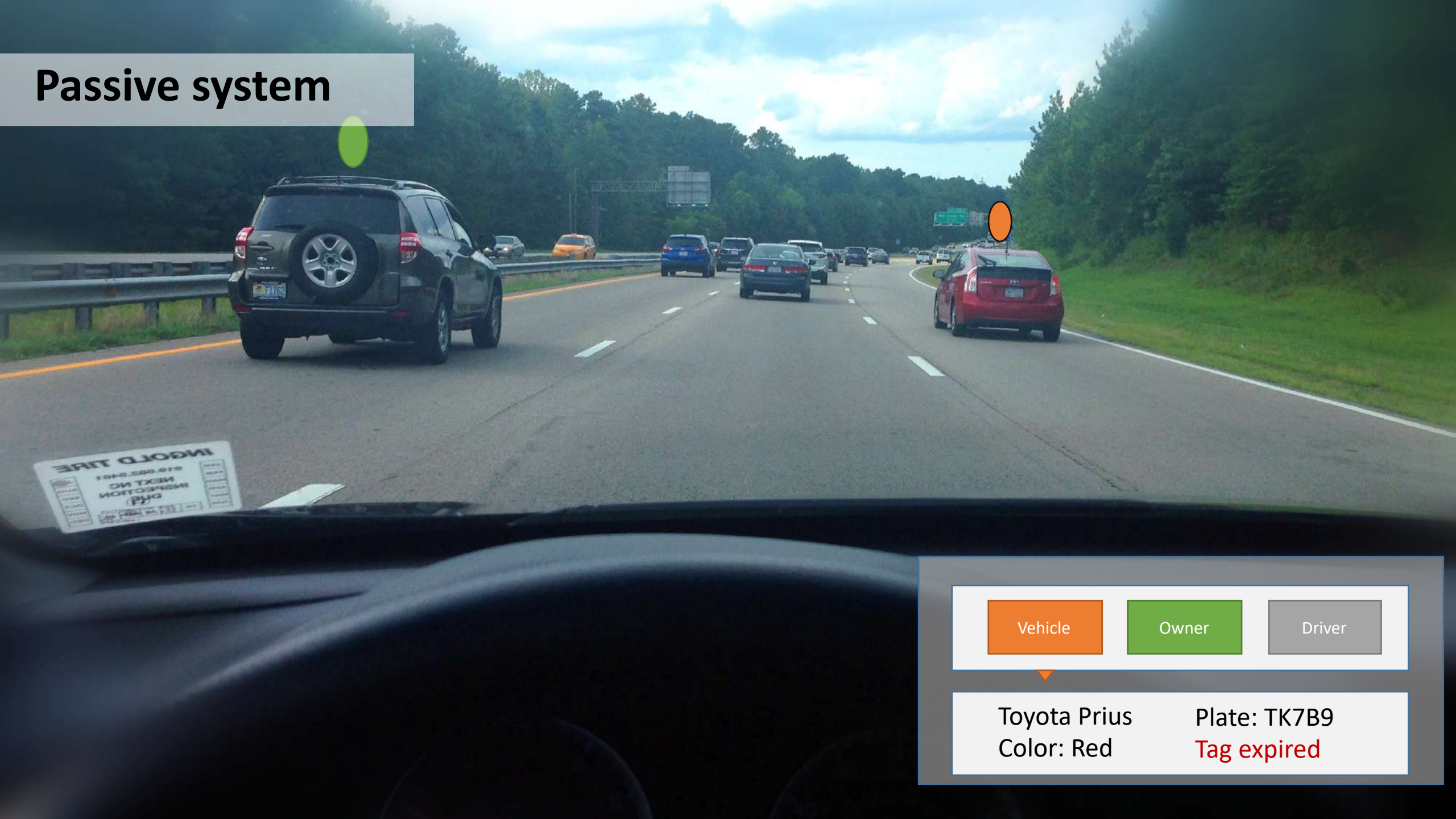
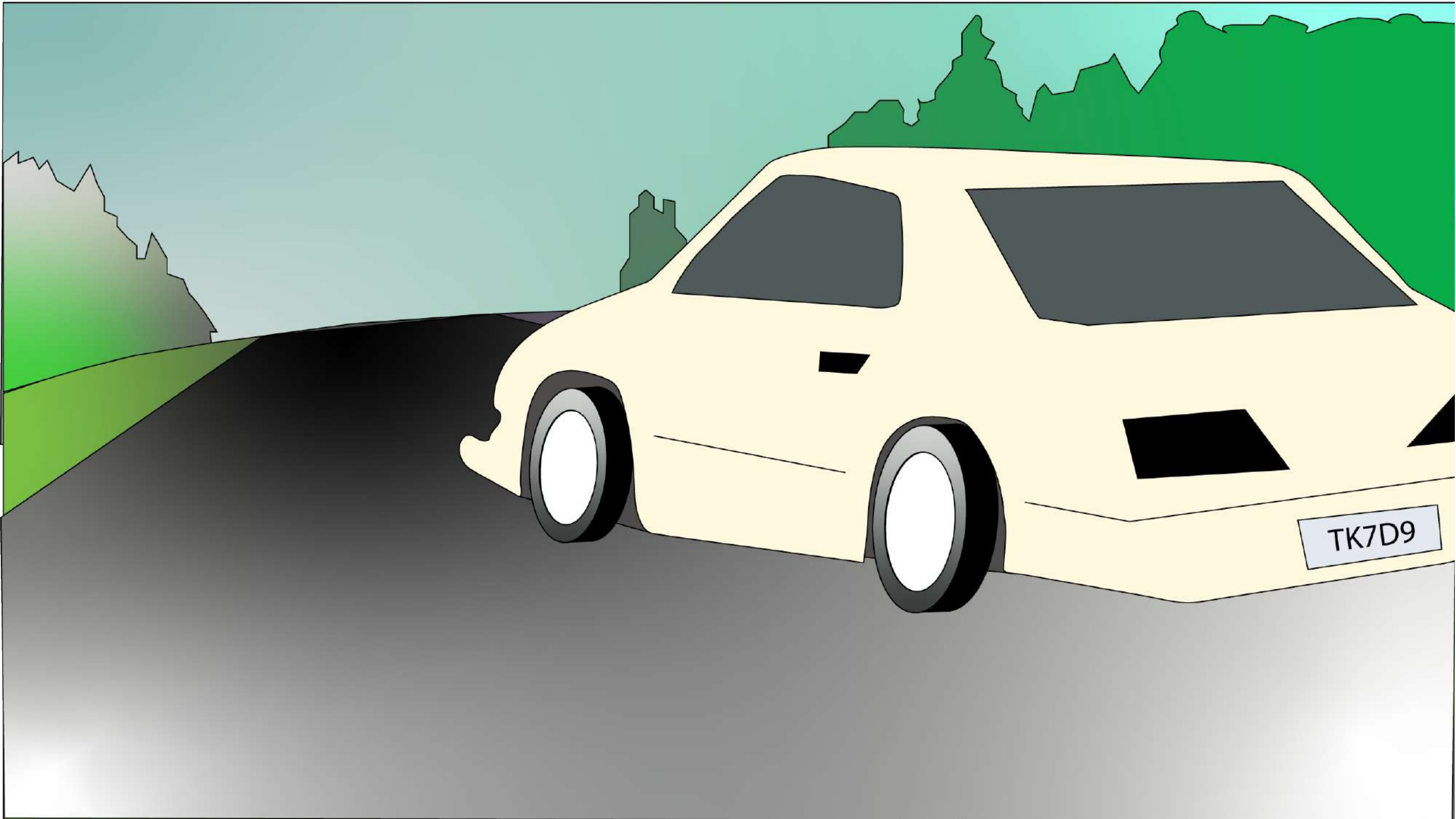
Car info

Passive system



Active system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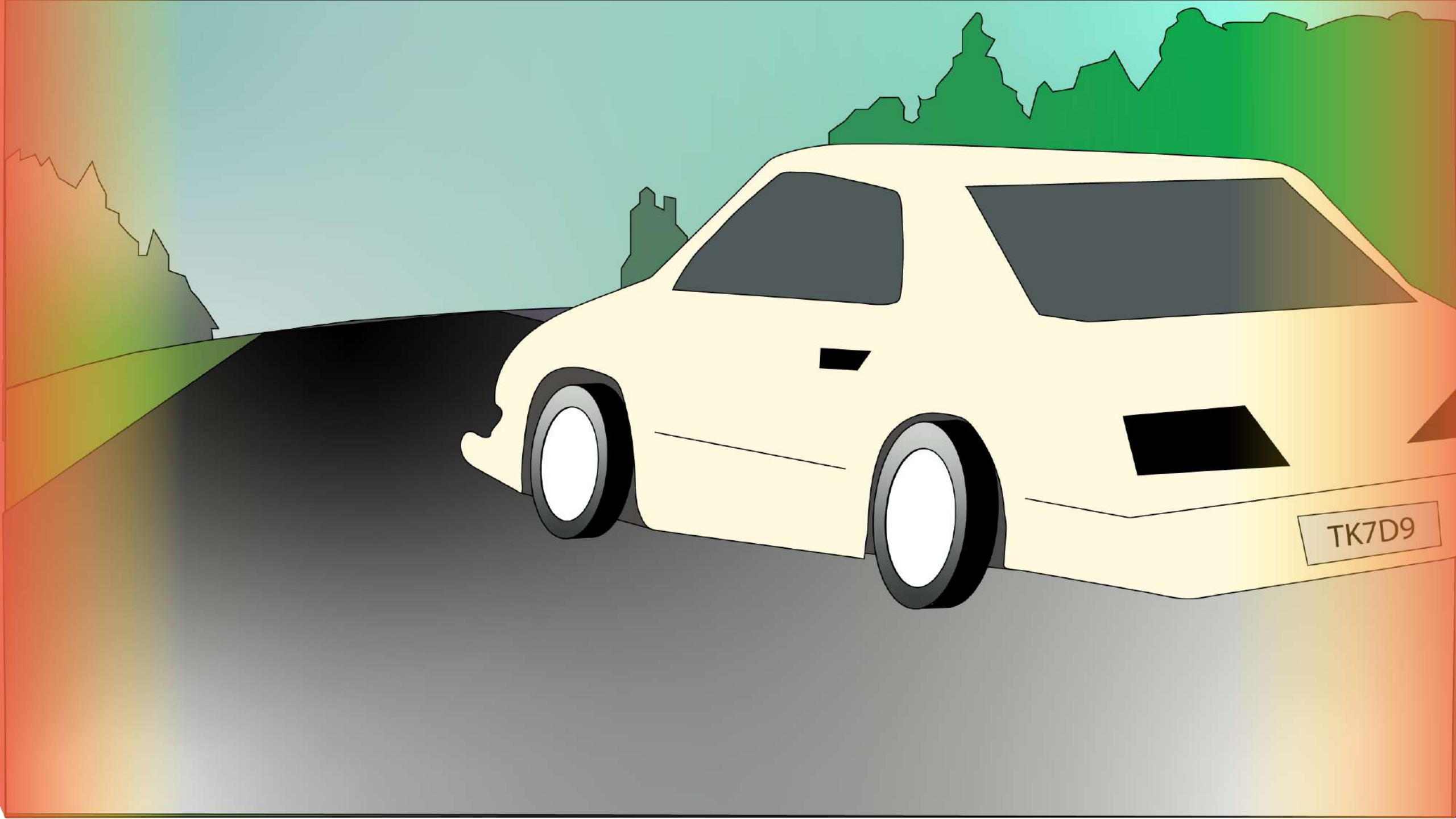
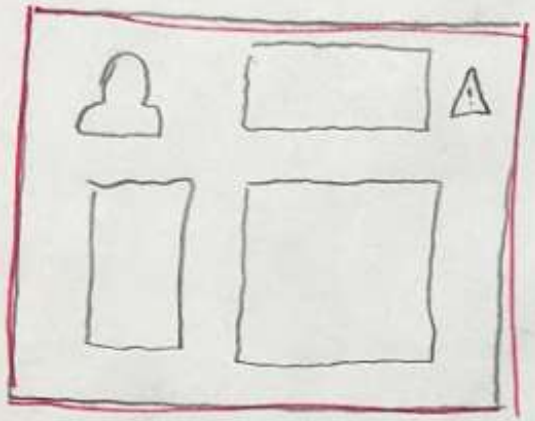
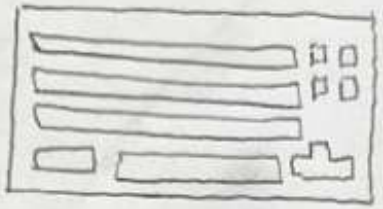
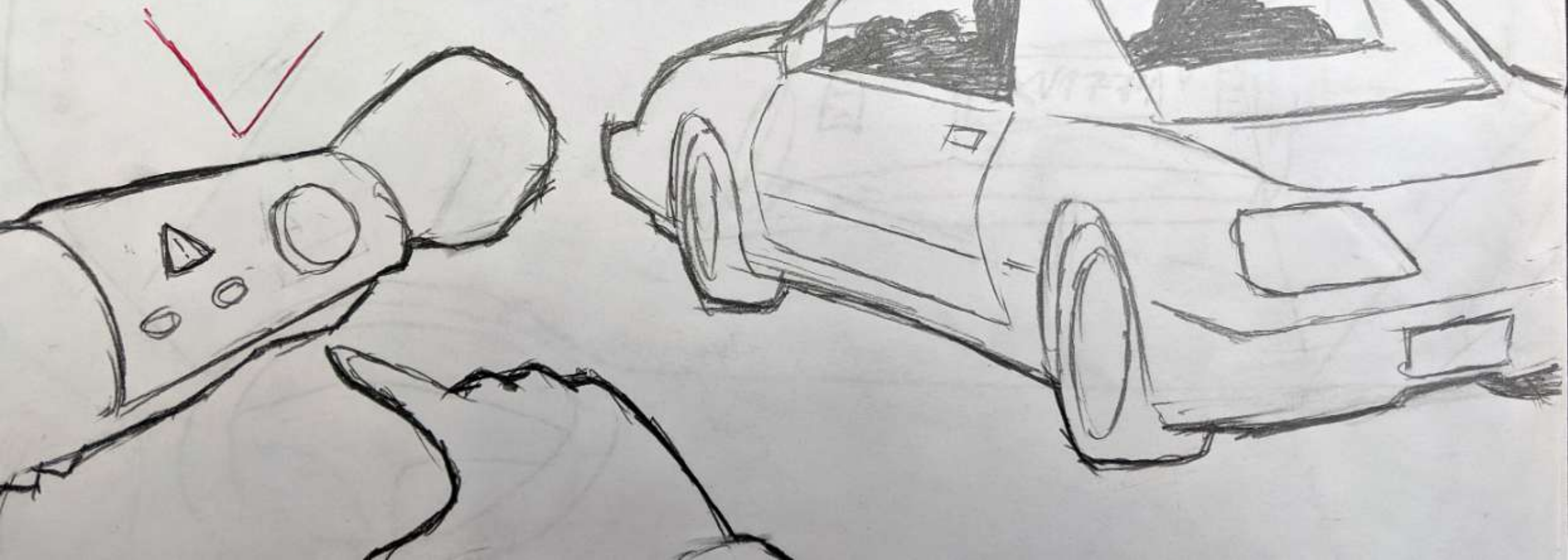

TK7D9

From car's computer

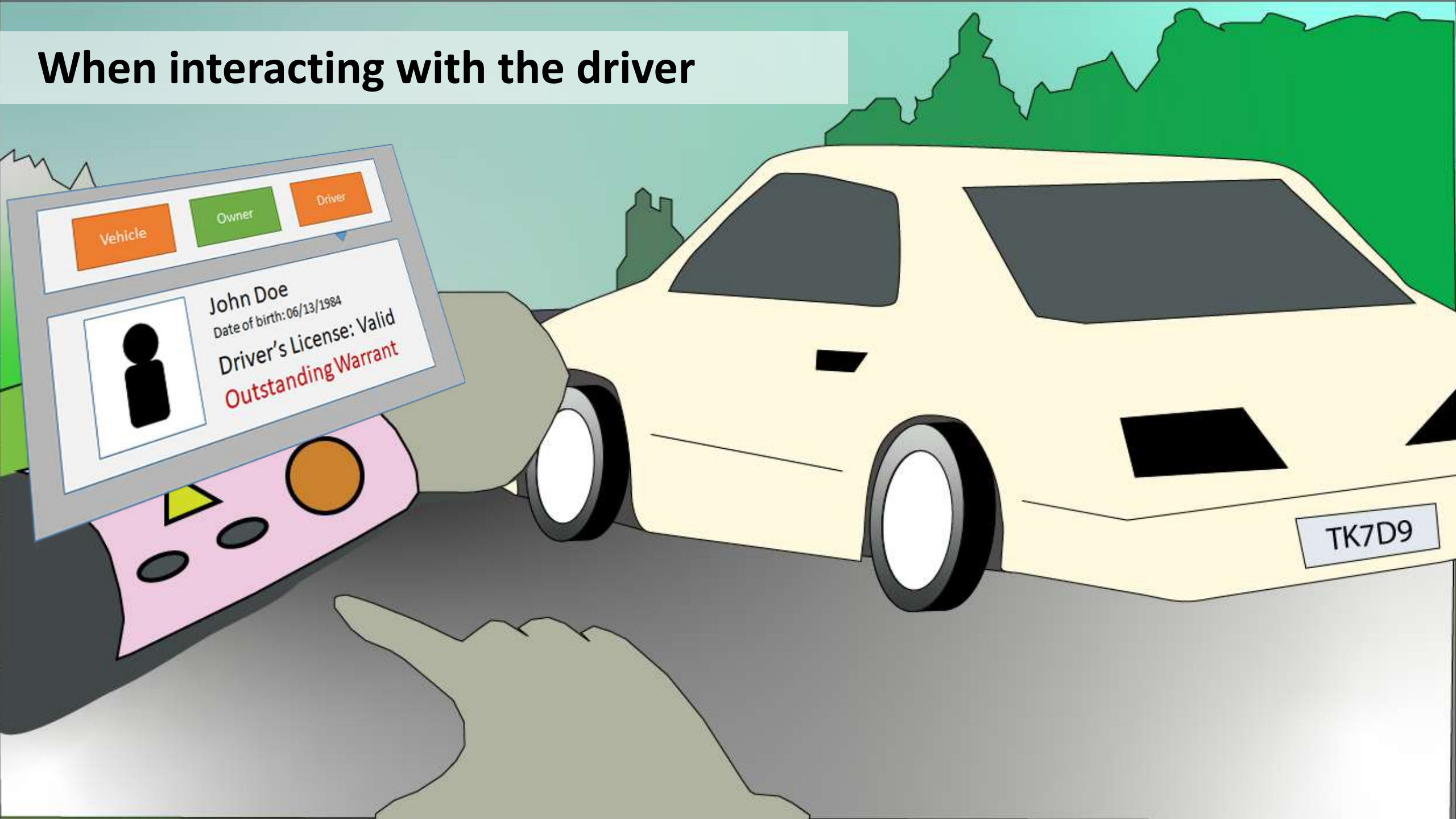


Keyboard AR



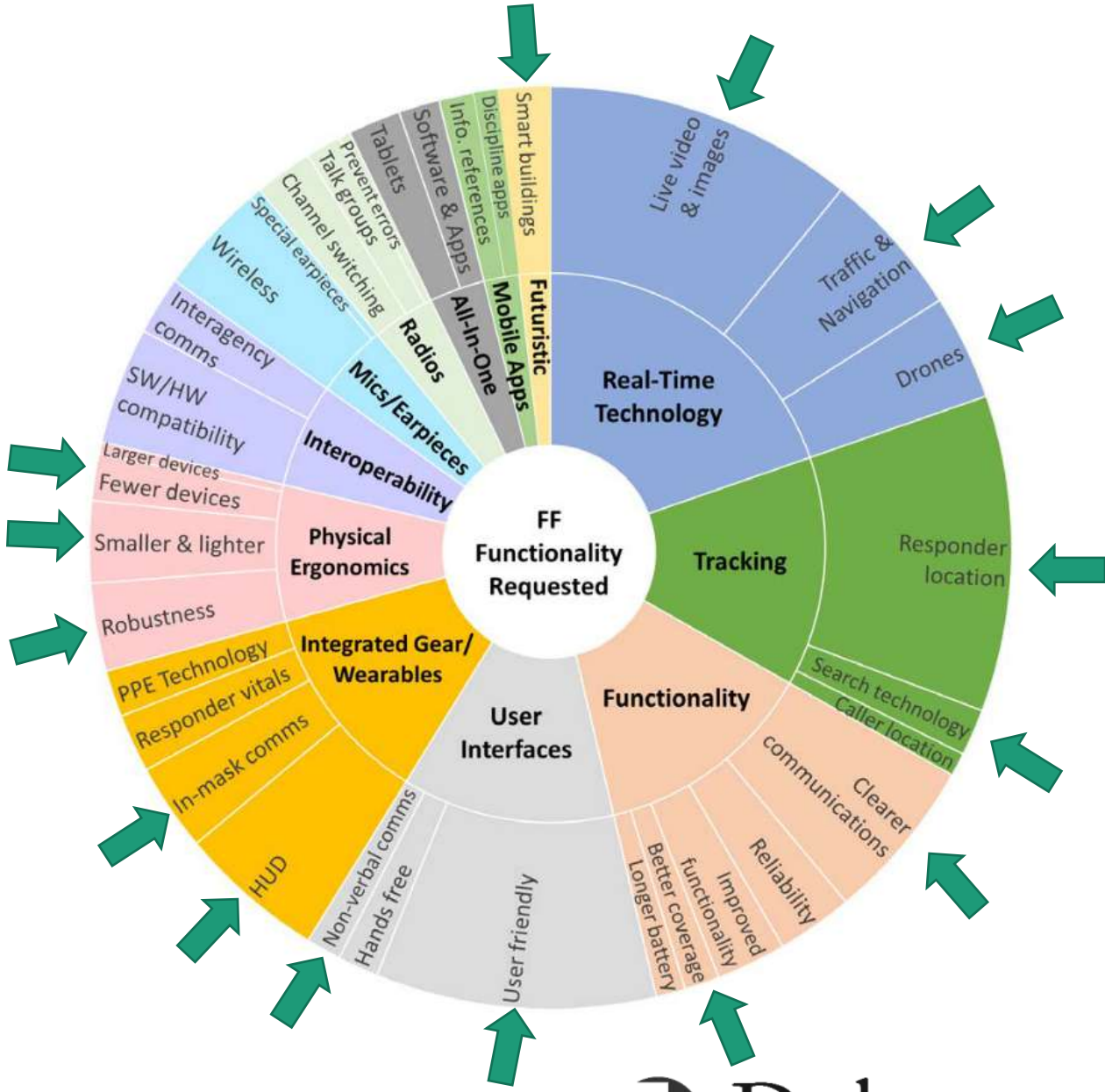


When interacting with the driver



Requirement Analysis - FF
Functionality Requested

- Information about the buildings, floor plans, people inside
- Interactive maps: tactical information, shared location, 3D maps,
- HUD: info about the environment, about the location of other folks
- Reliable systems
- Drone footage, 360 video of the scene before get there
- Lighter equipment, smaller
- Easy way to report (paper work)



("Voices of First Responders" Dawkins et al. 2018)

Requirement Analysis - FF

Chosen Scenario: Search and Rescue

Scenario	Burning commercial building
Key Role	Firefighter who's tasked with finding the victim
Task to simulate	Search + rescue: Path finding (in and out), hazard detection and avoidance, victim detection

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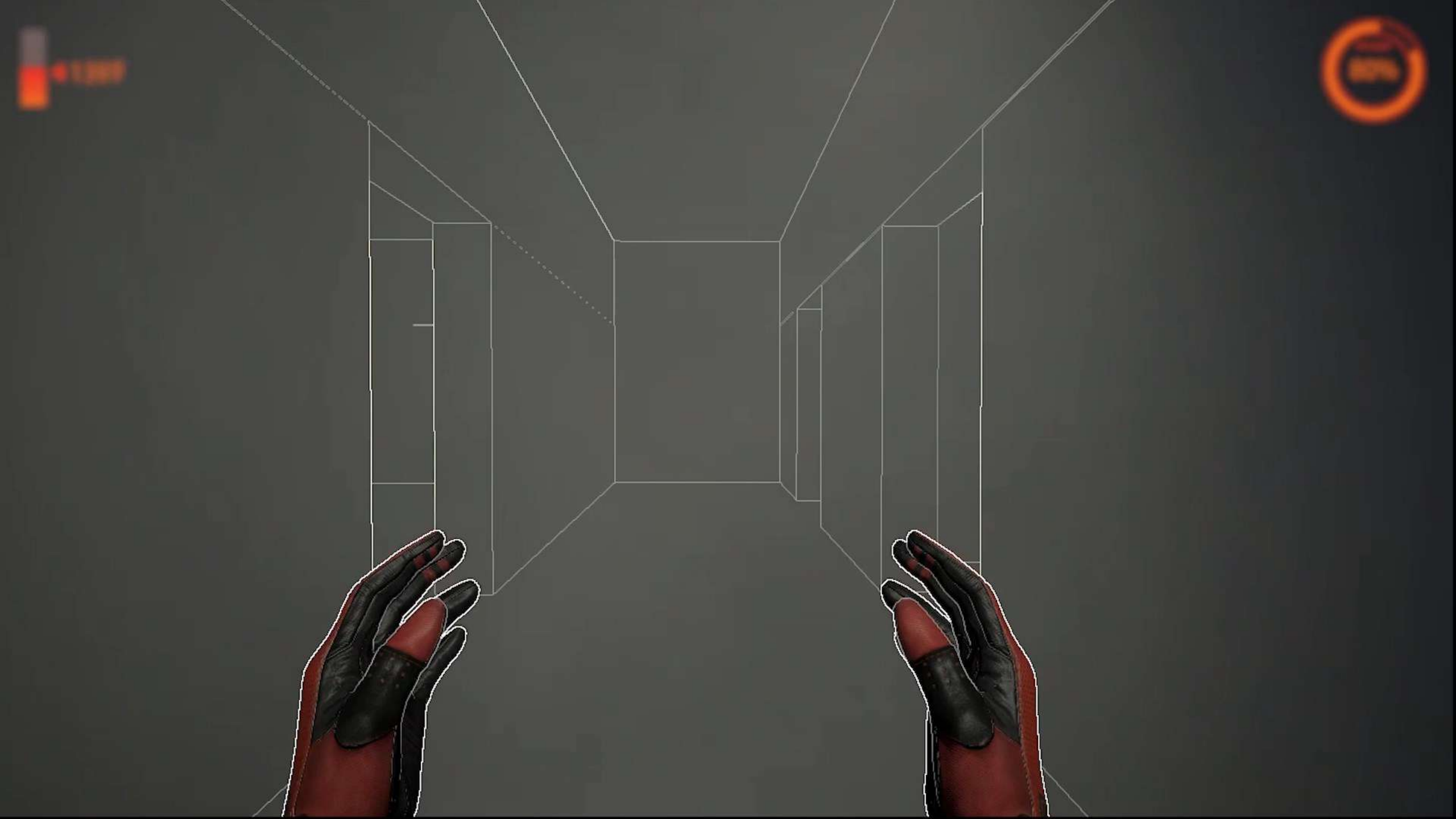
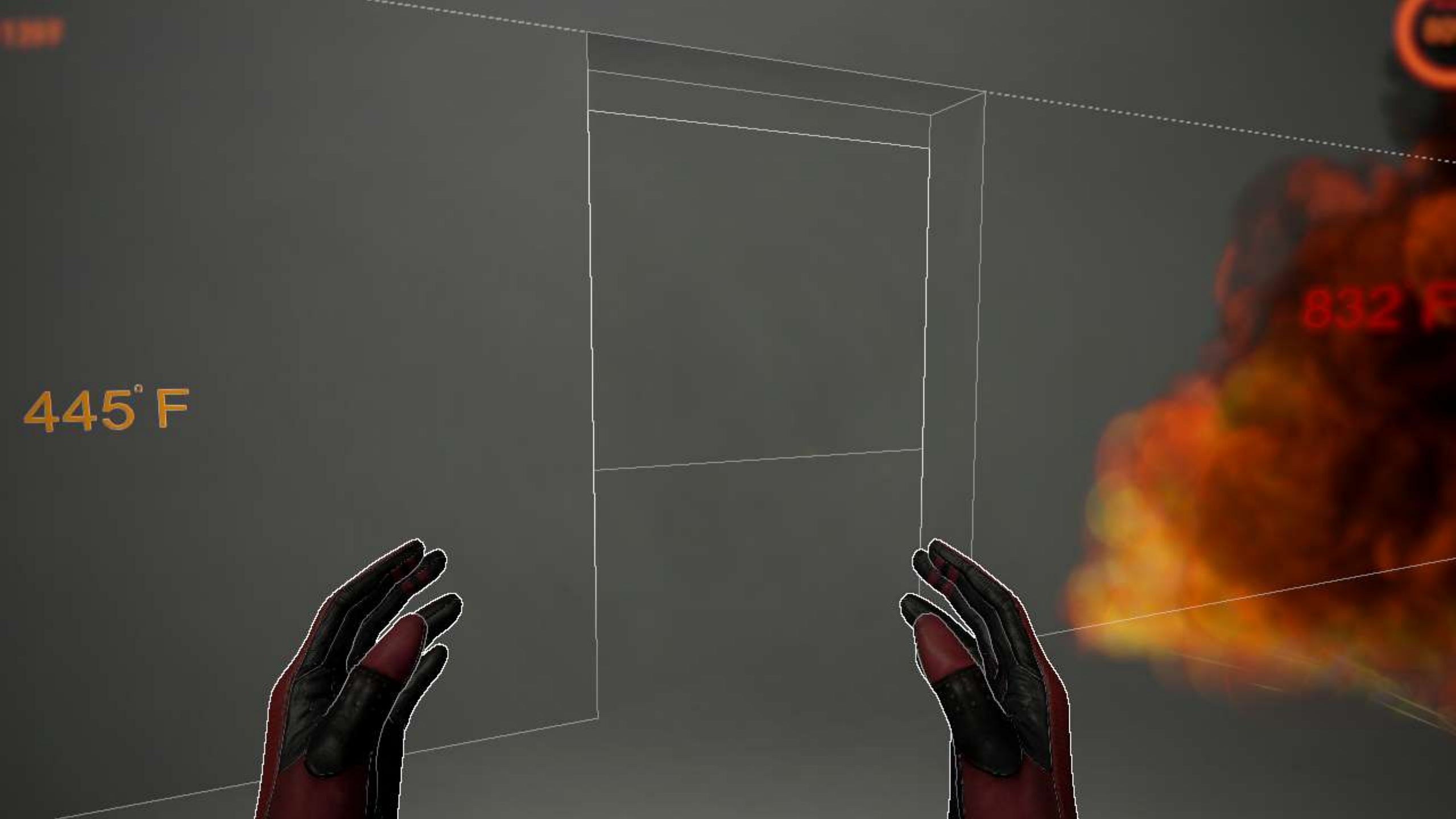
▷ Double-click ◁
button on side
of O2 mask
to activate HUD




445° F
832 F


Temp.
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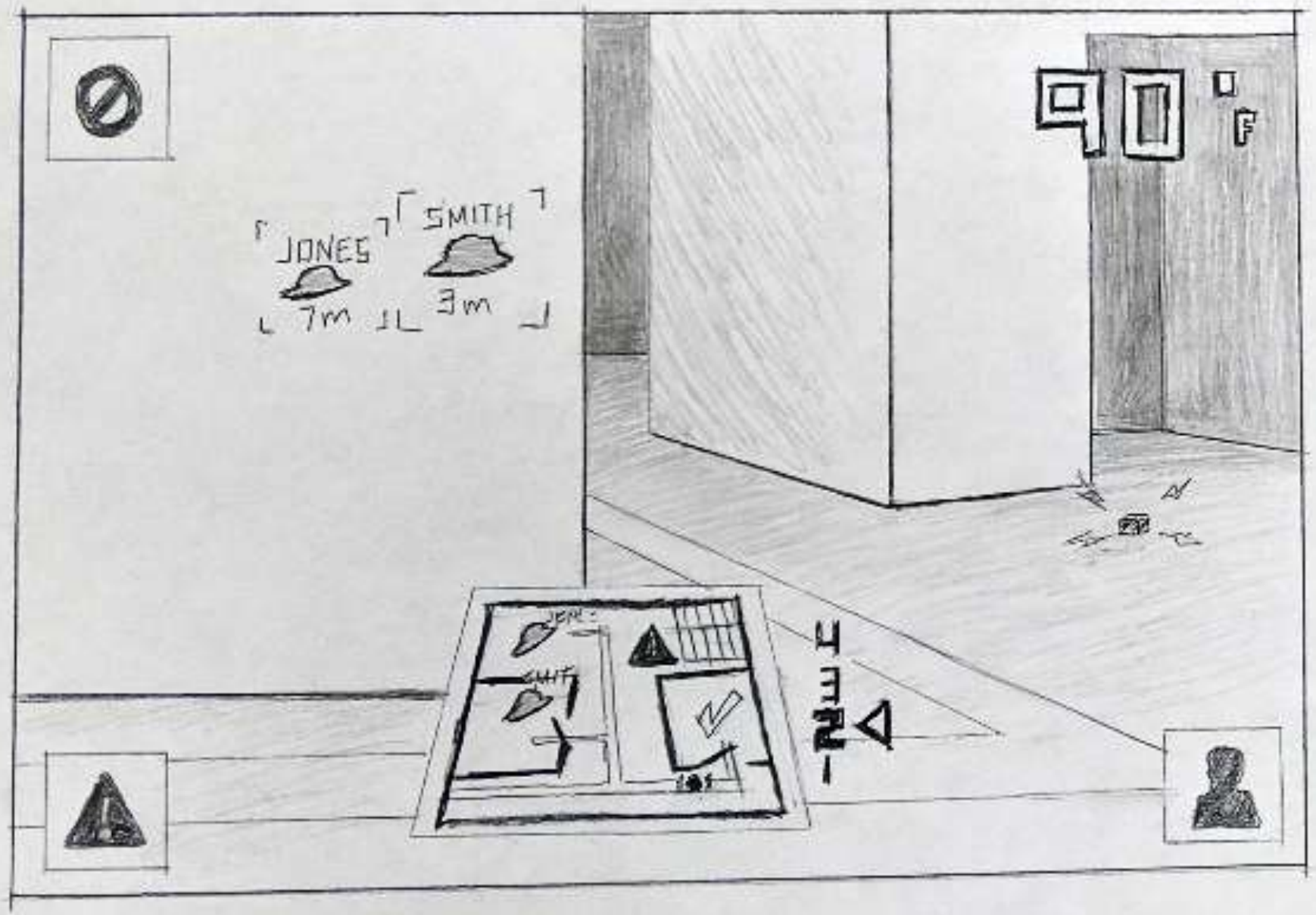
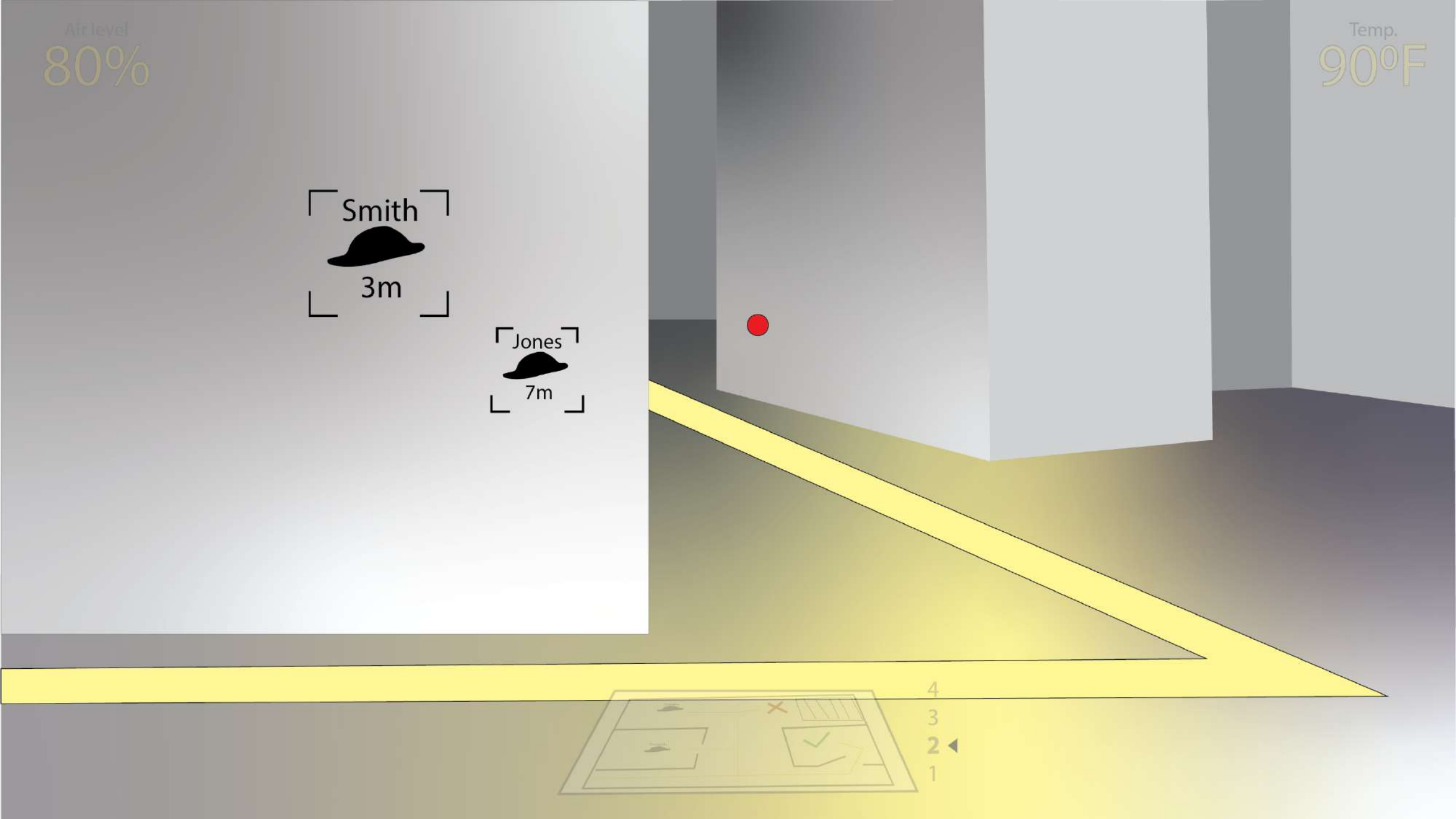
Air Level
80%


Temp.
139°F
Air Level
80%

FIREFIGHTER HUD 1

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Jones
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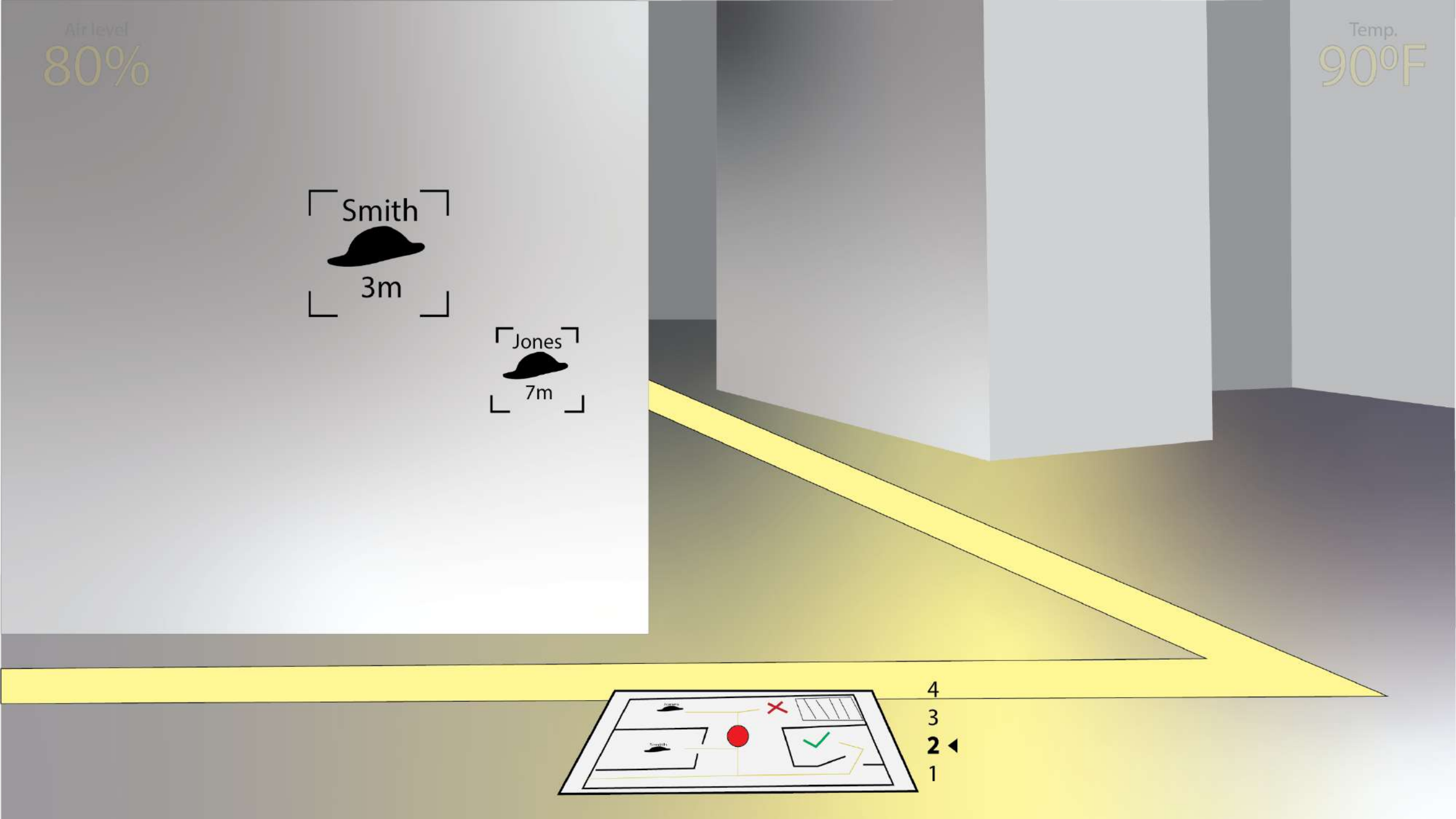
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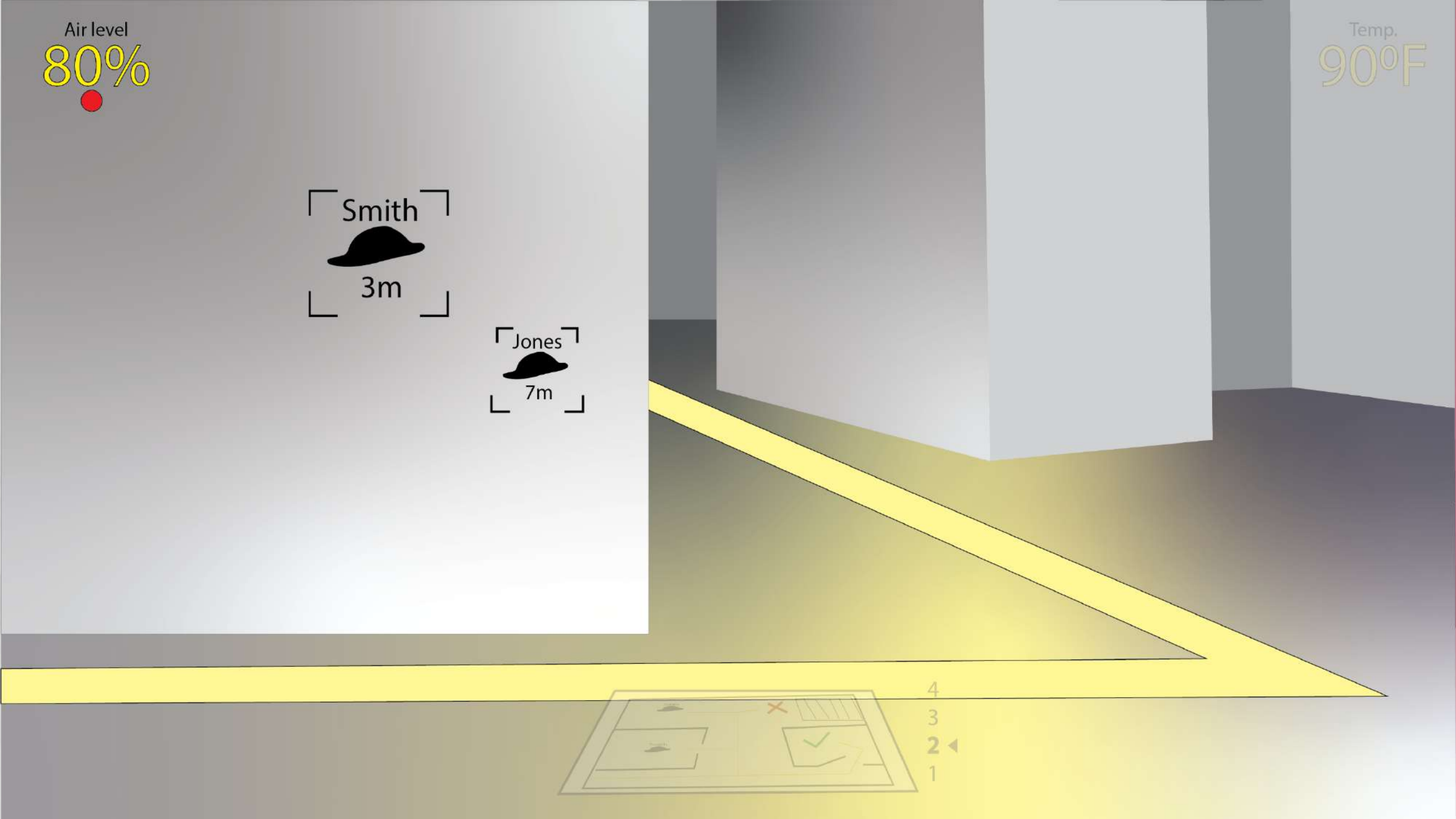
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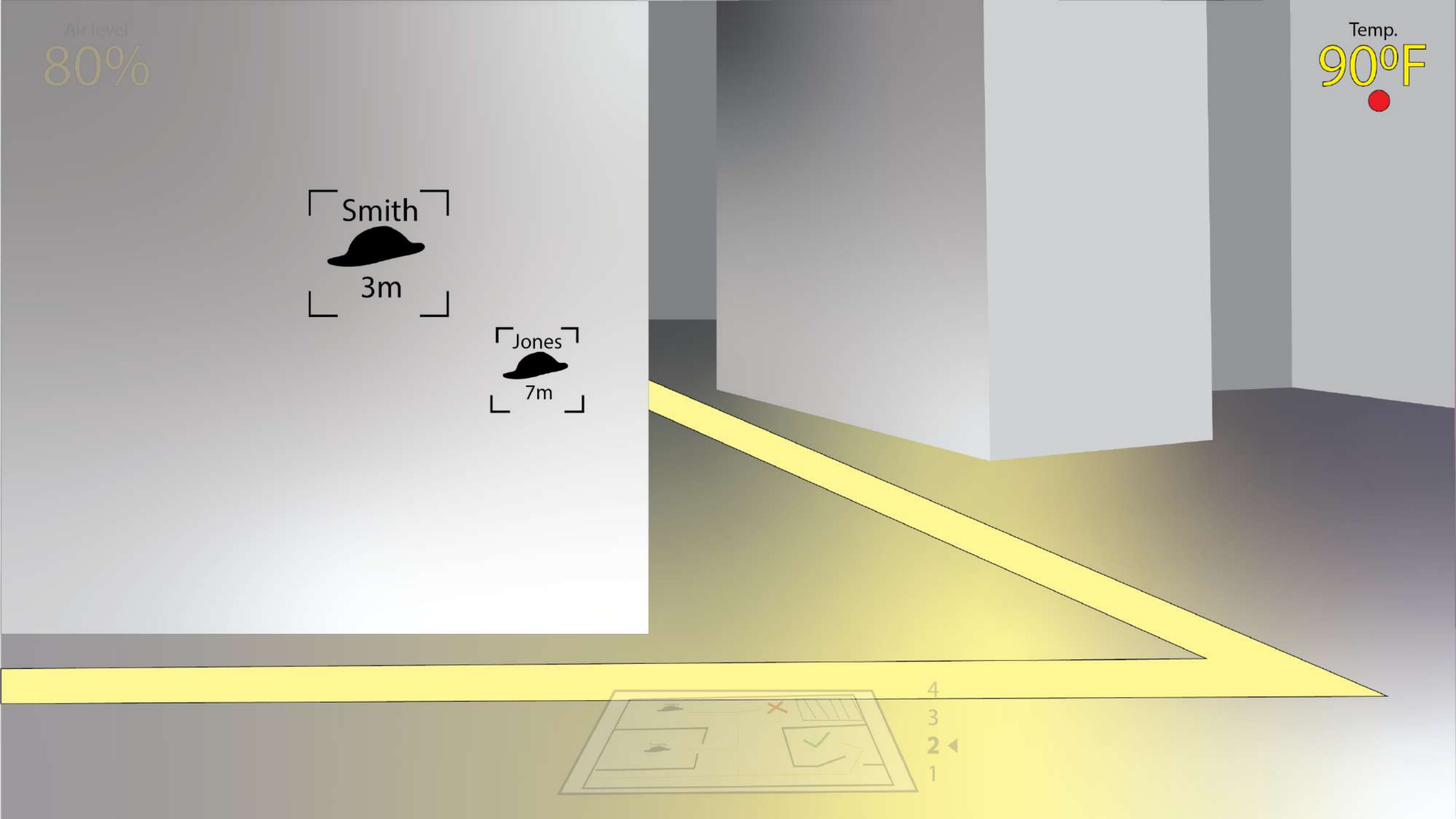
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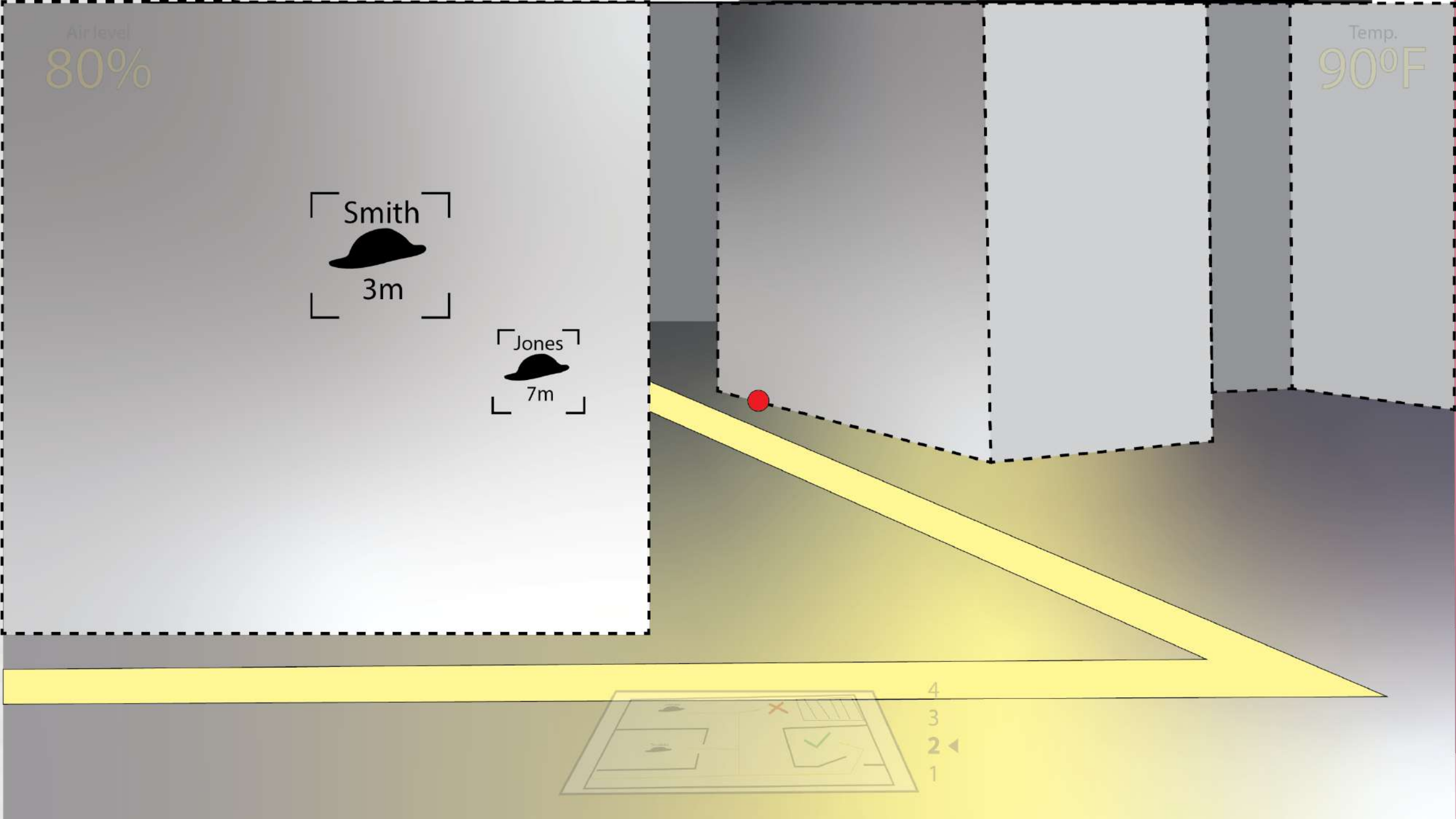
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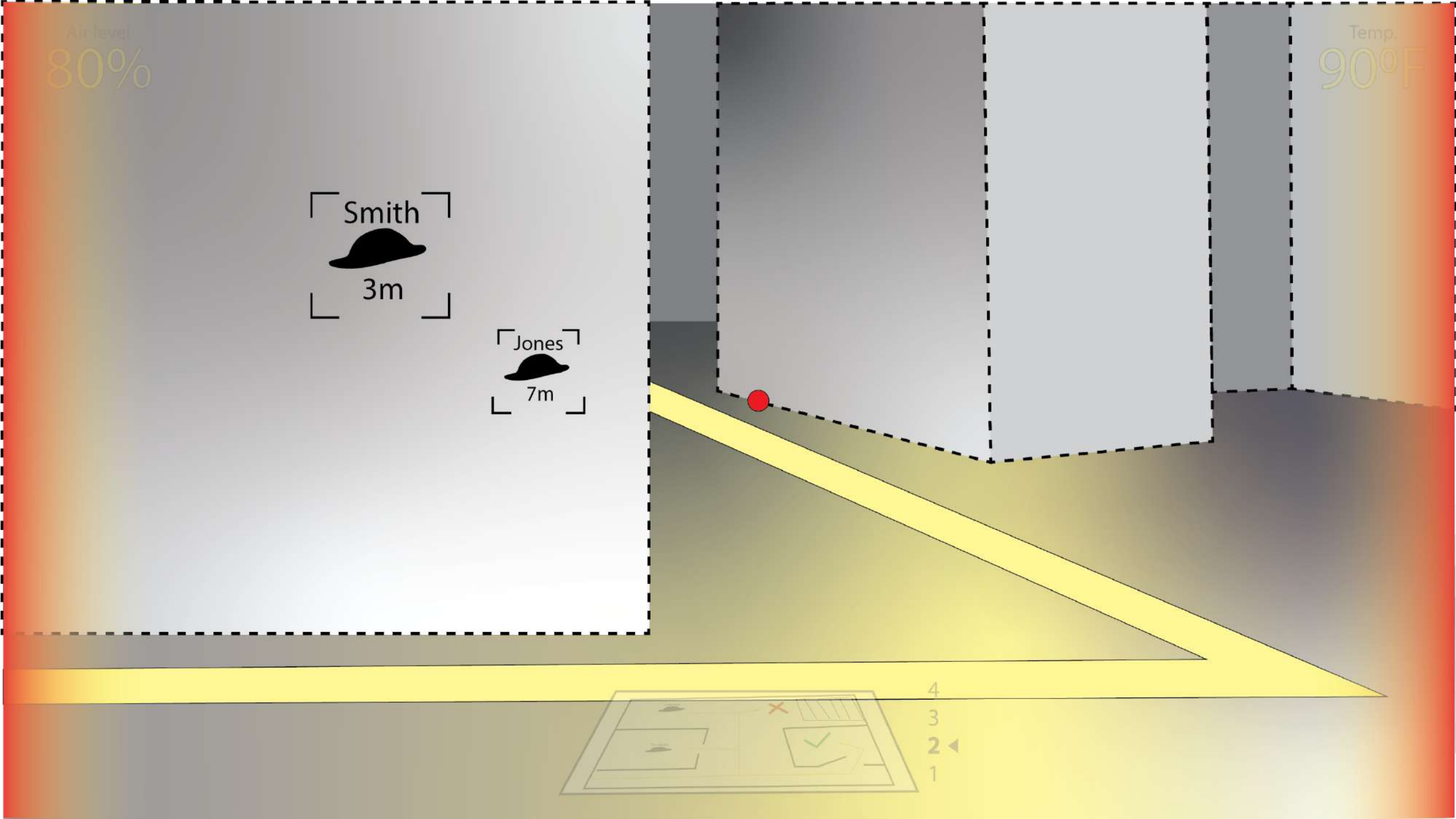
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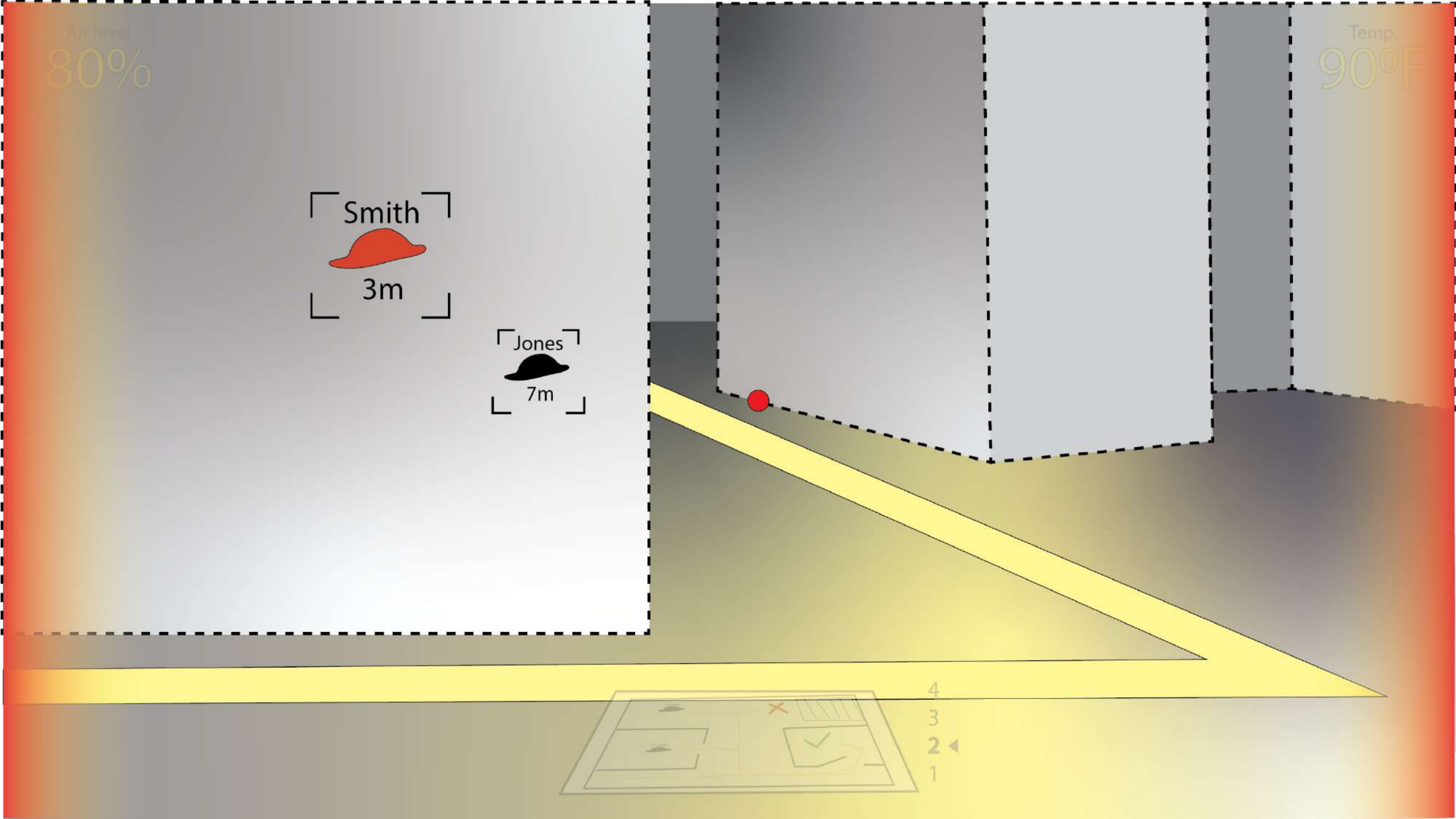
Air level
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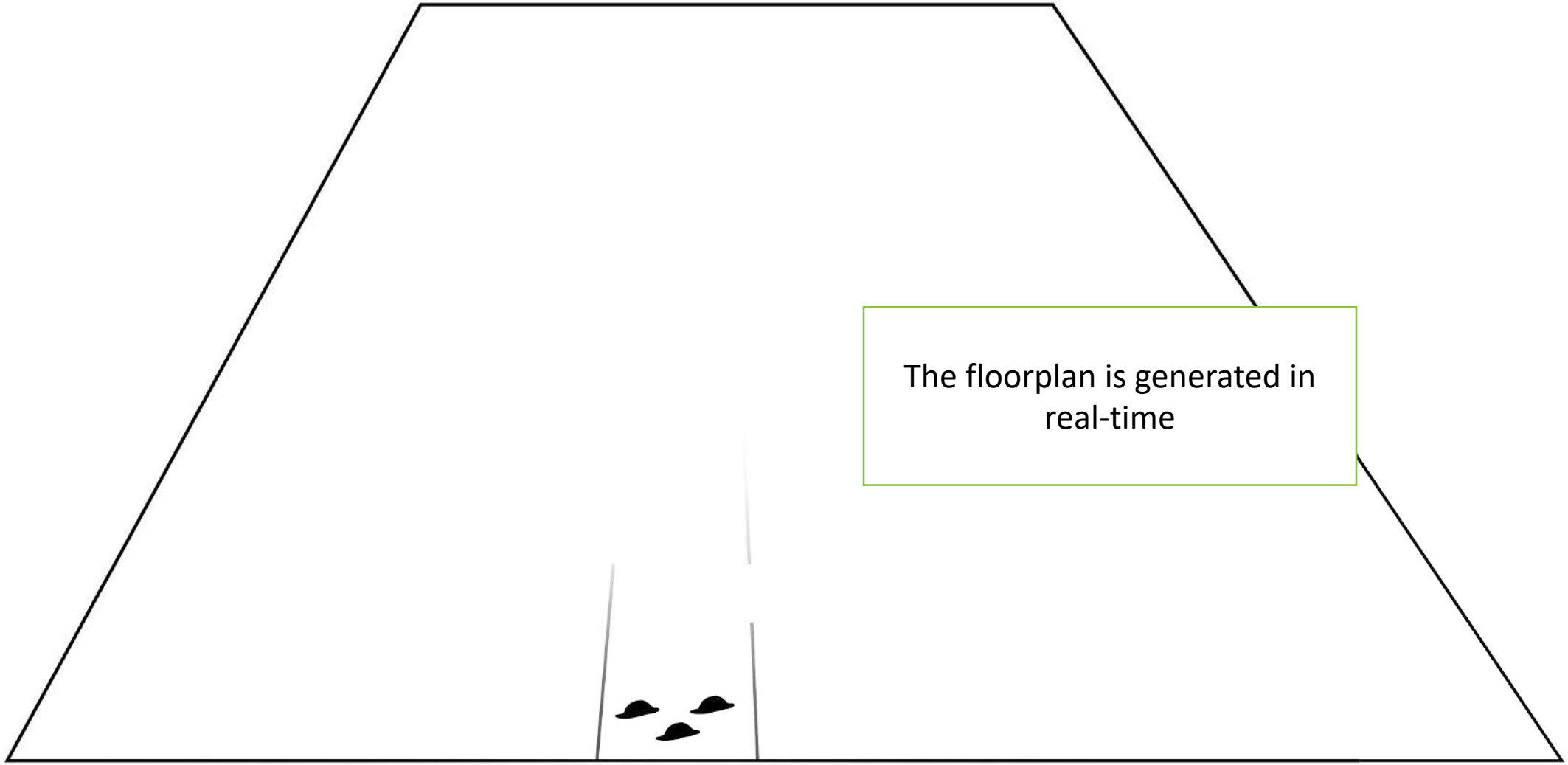
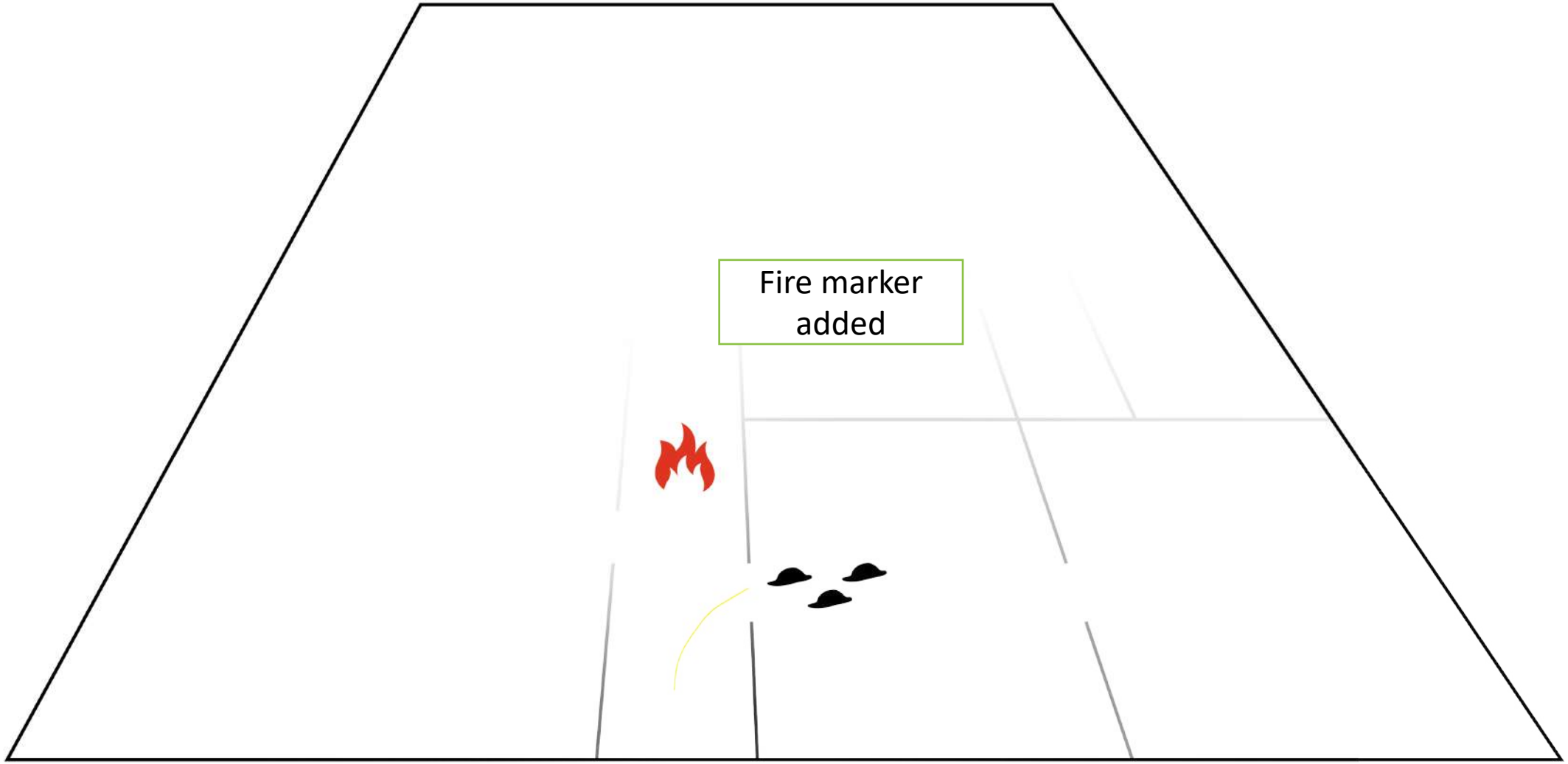
Dynamically generated floorplan



Dynamically generated floorplan



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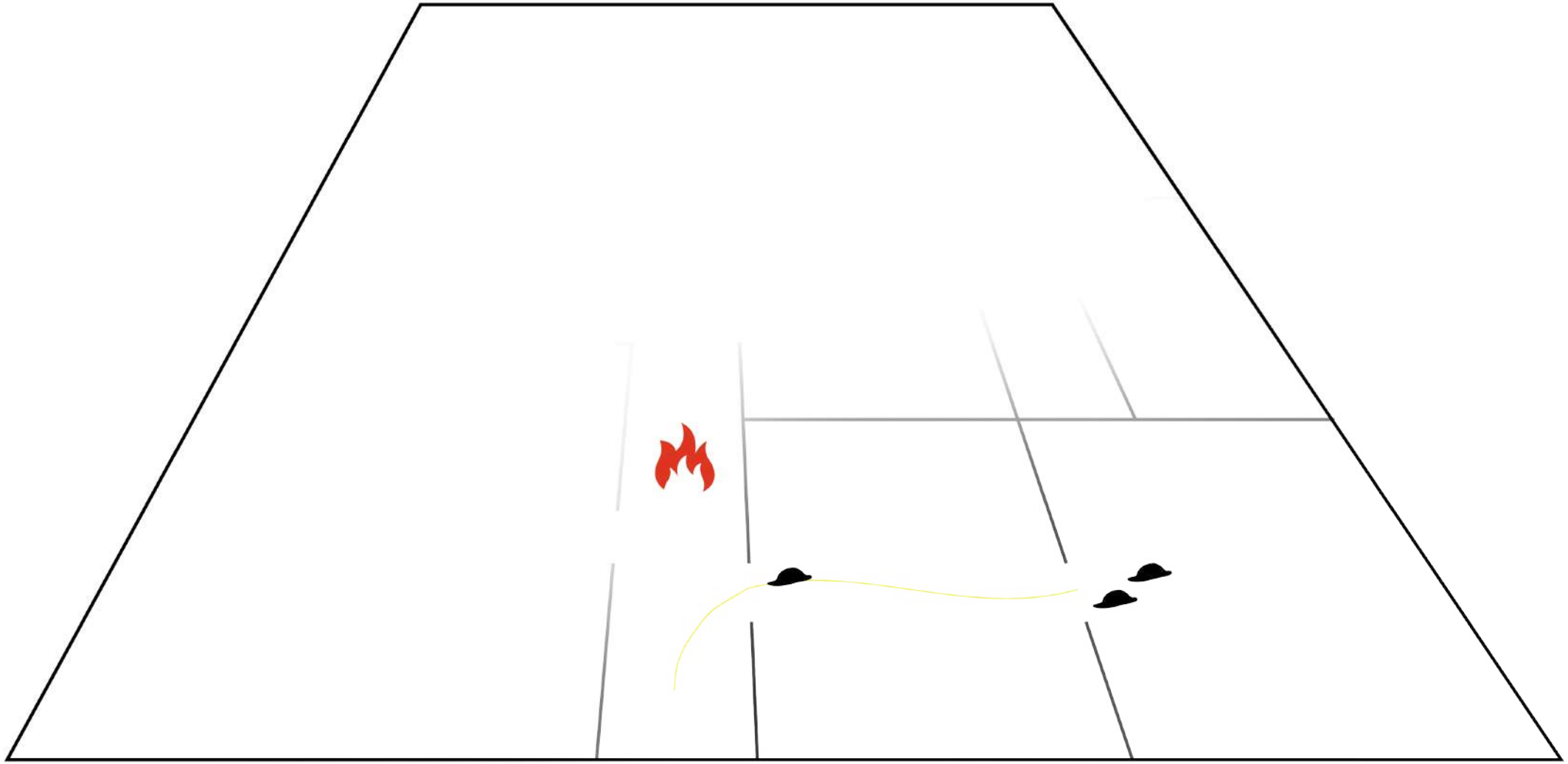
Dynamically generated floorplan



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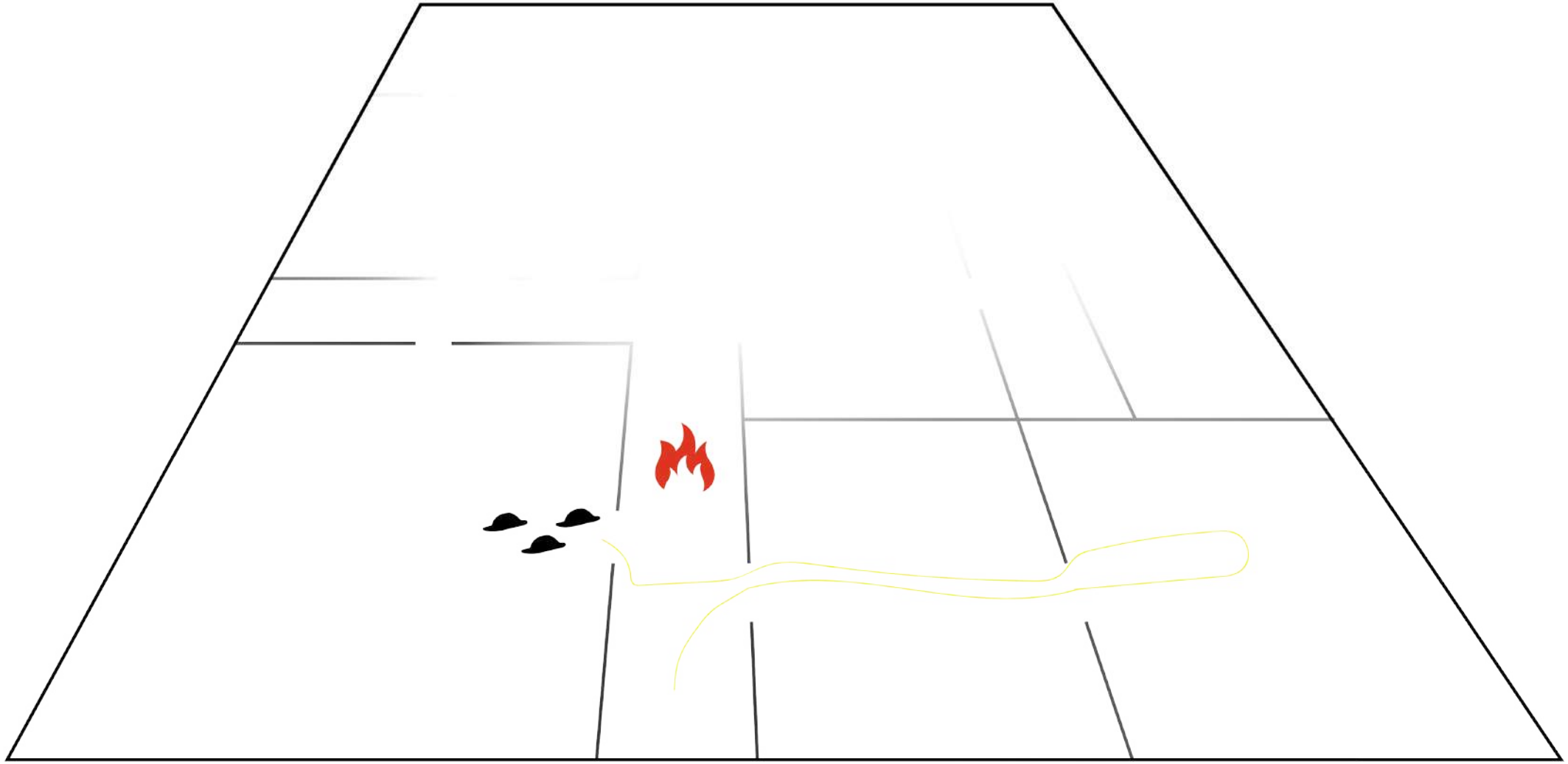
Dynamically generated floorplan



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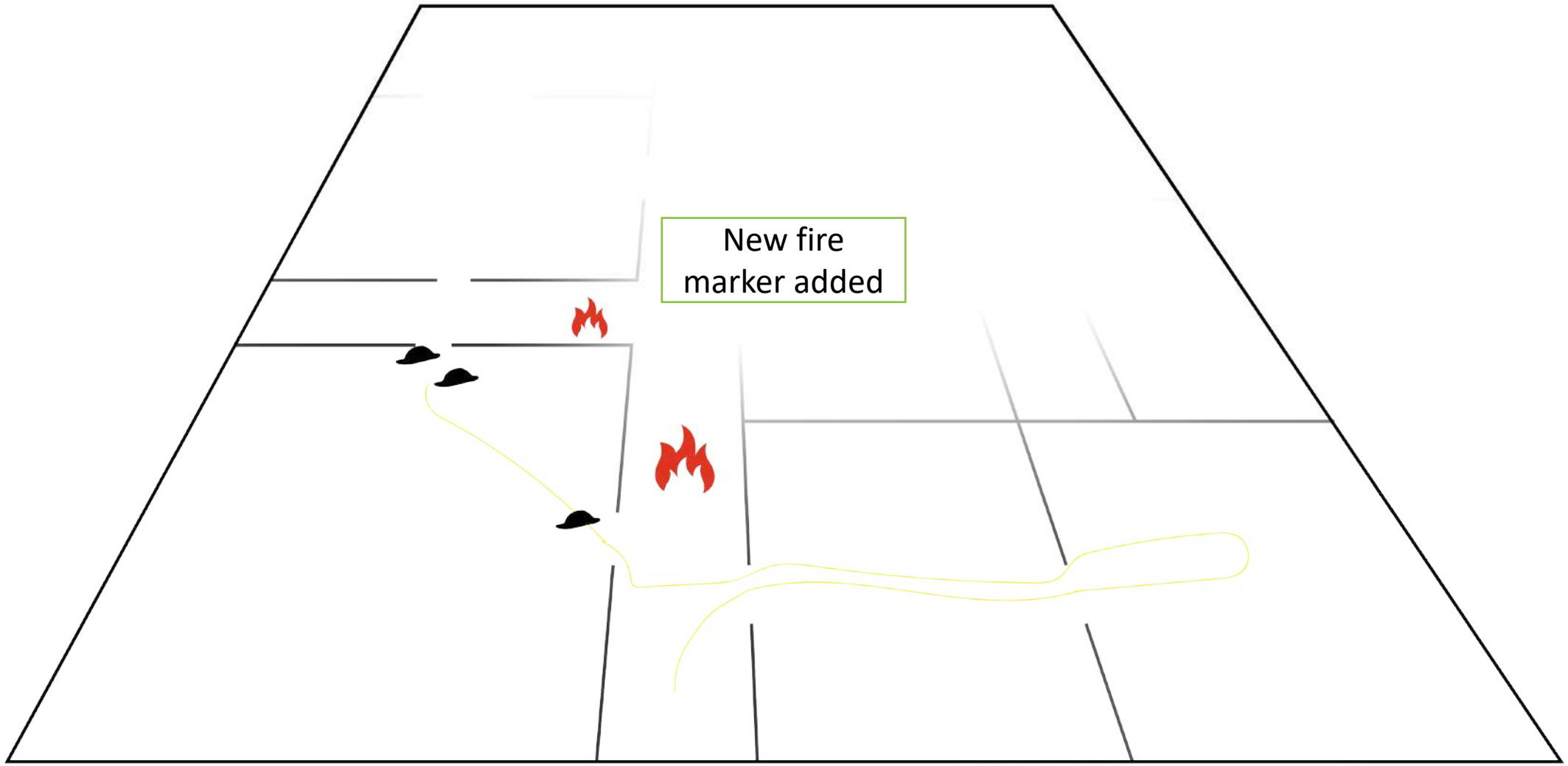
Dynamically generated floorplan



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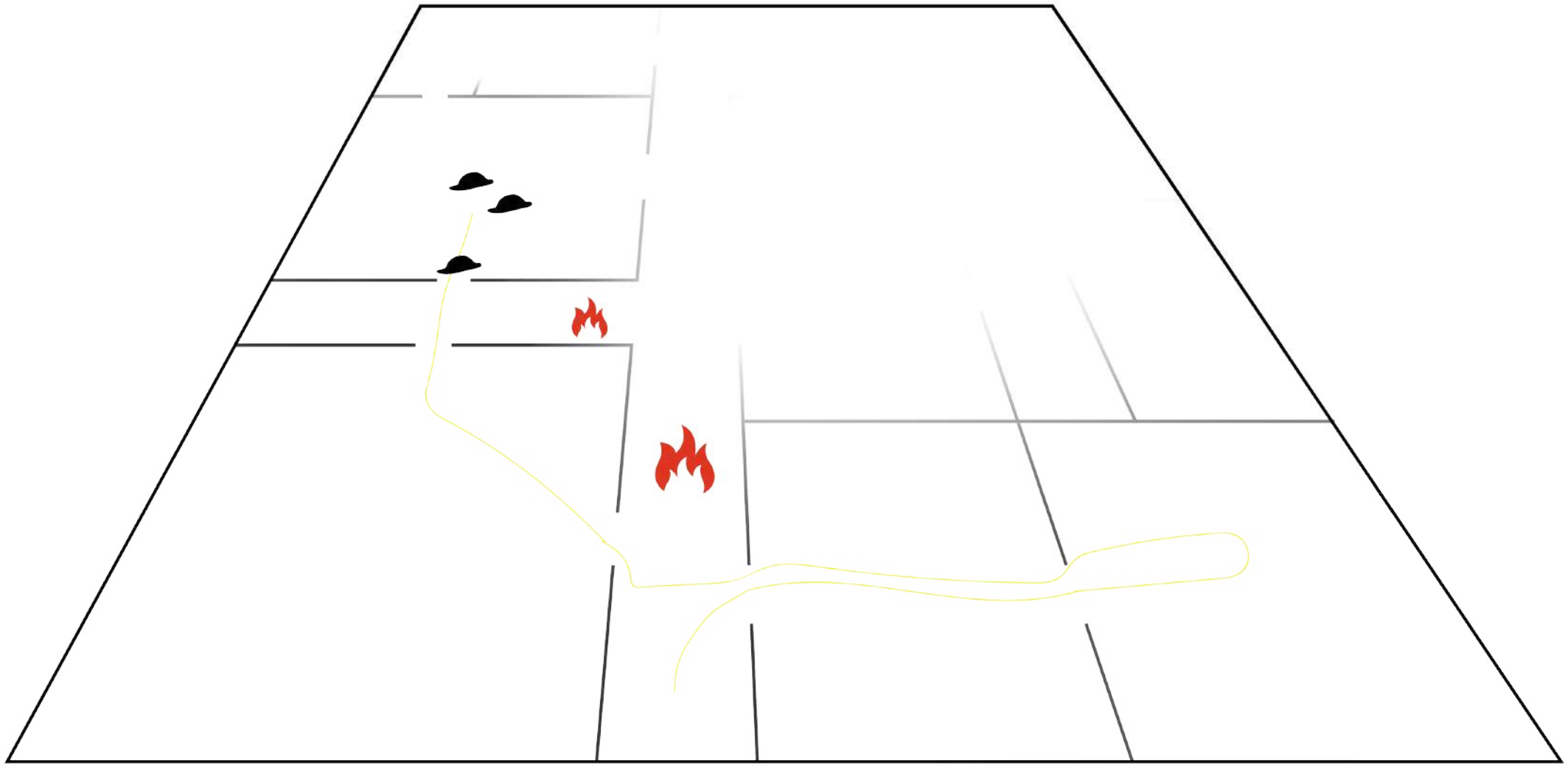
Dynamically generated floorplan



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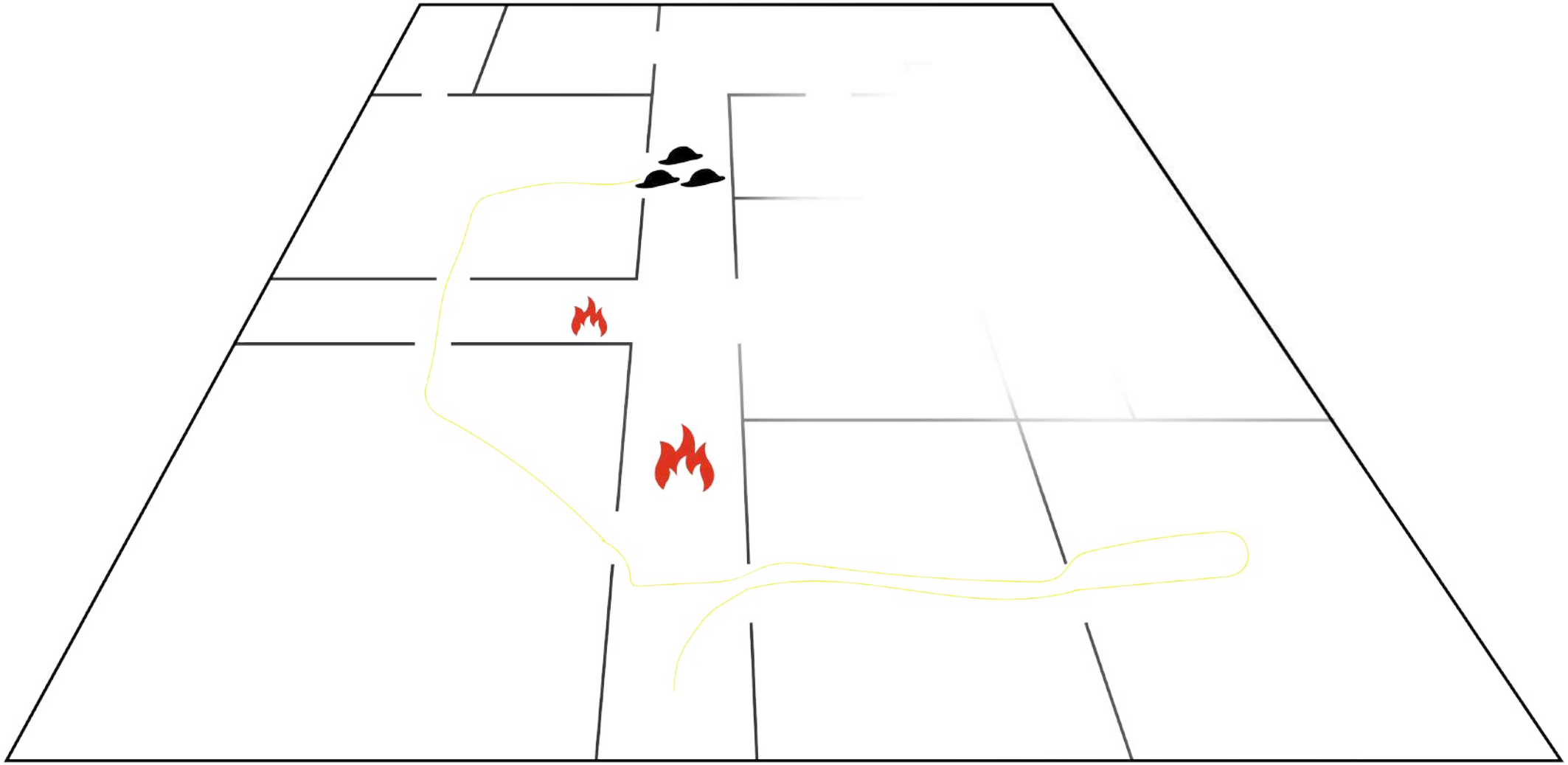
Dynamically generated floorplan



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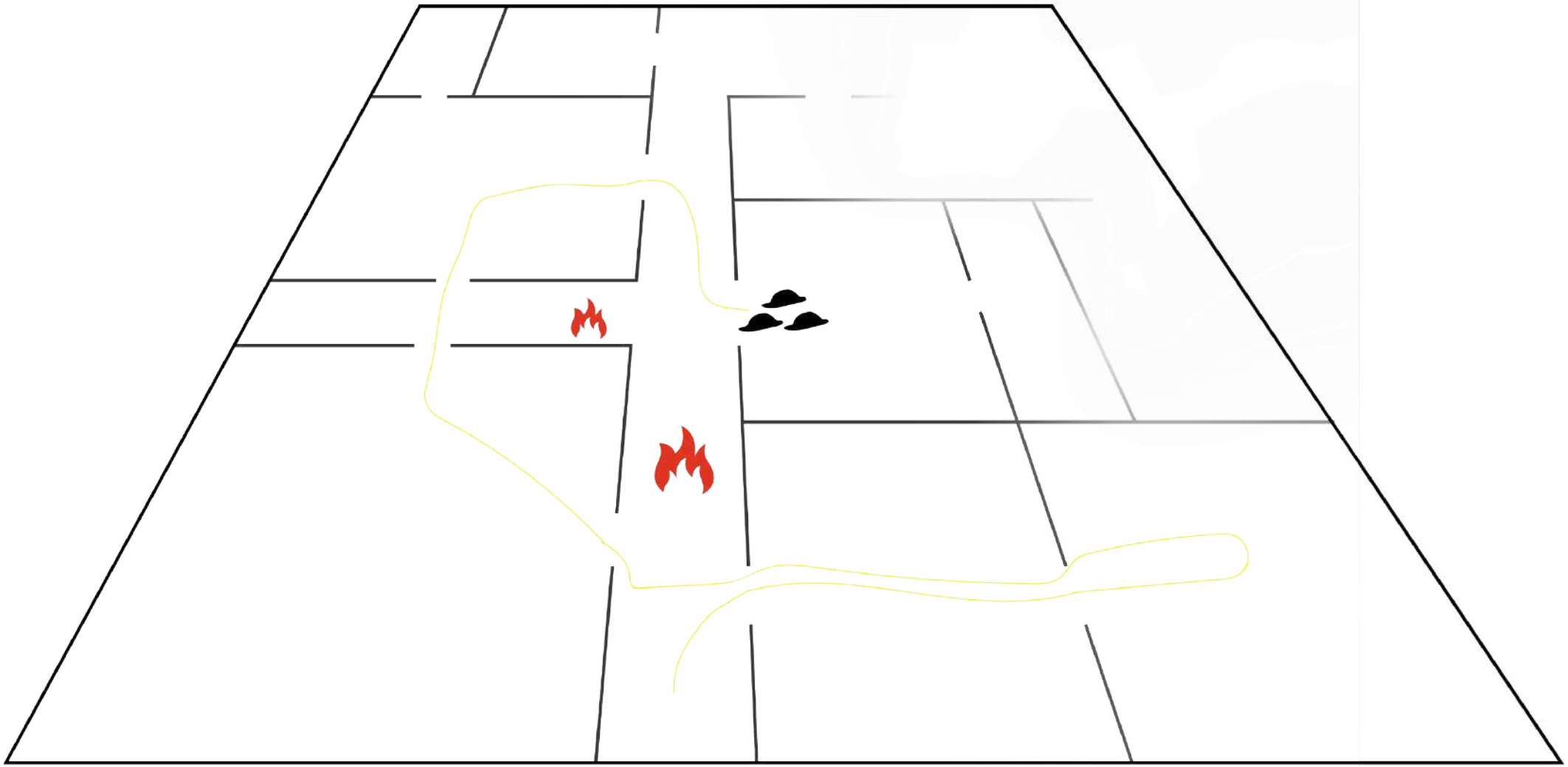
Dynamically generated floorplan



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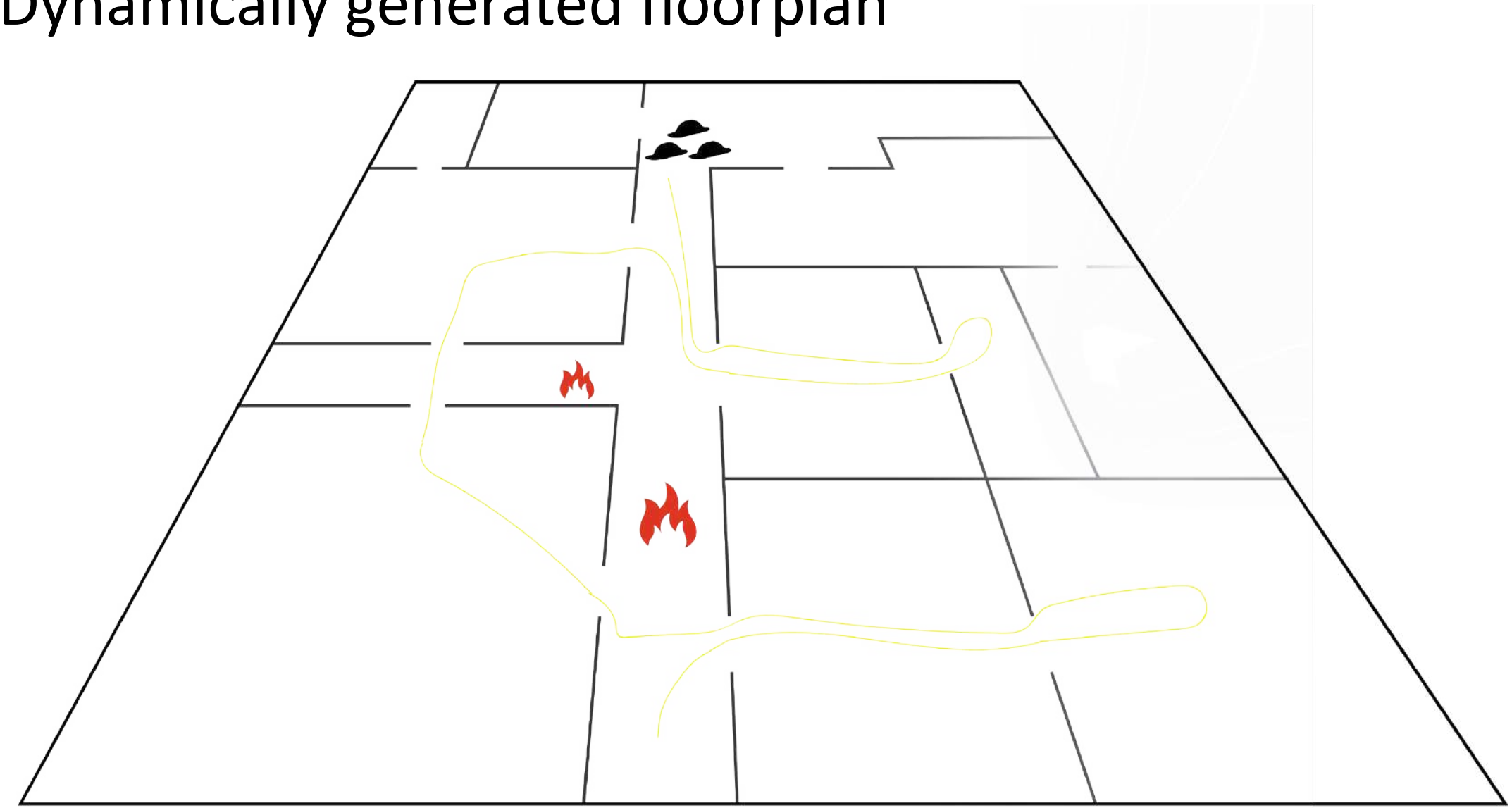
Dynamically generated floorplan



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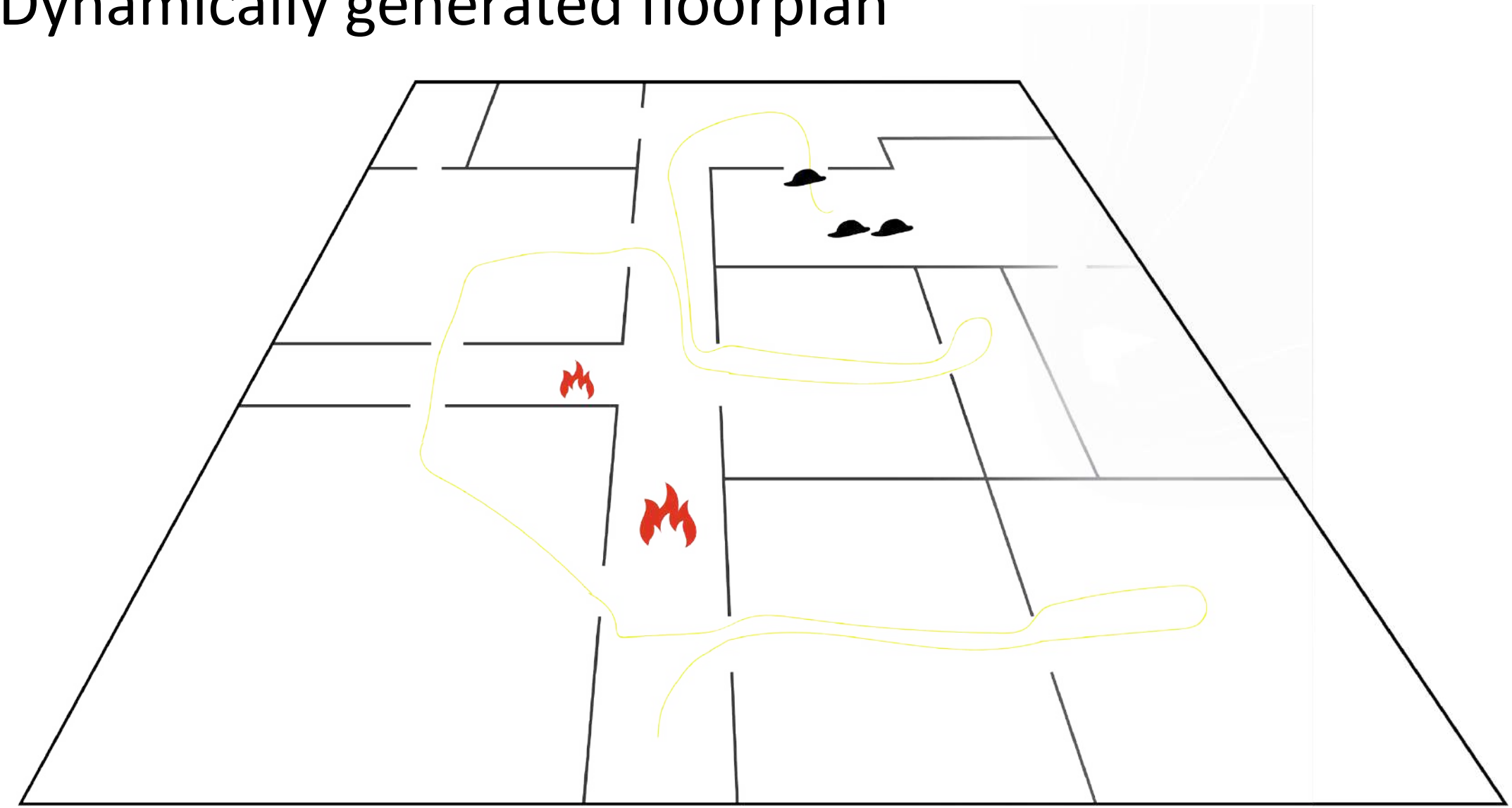
Dynamically generated floorplan



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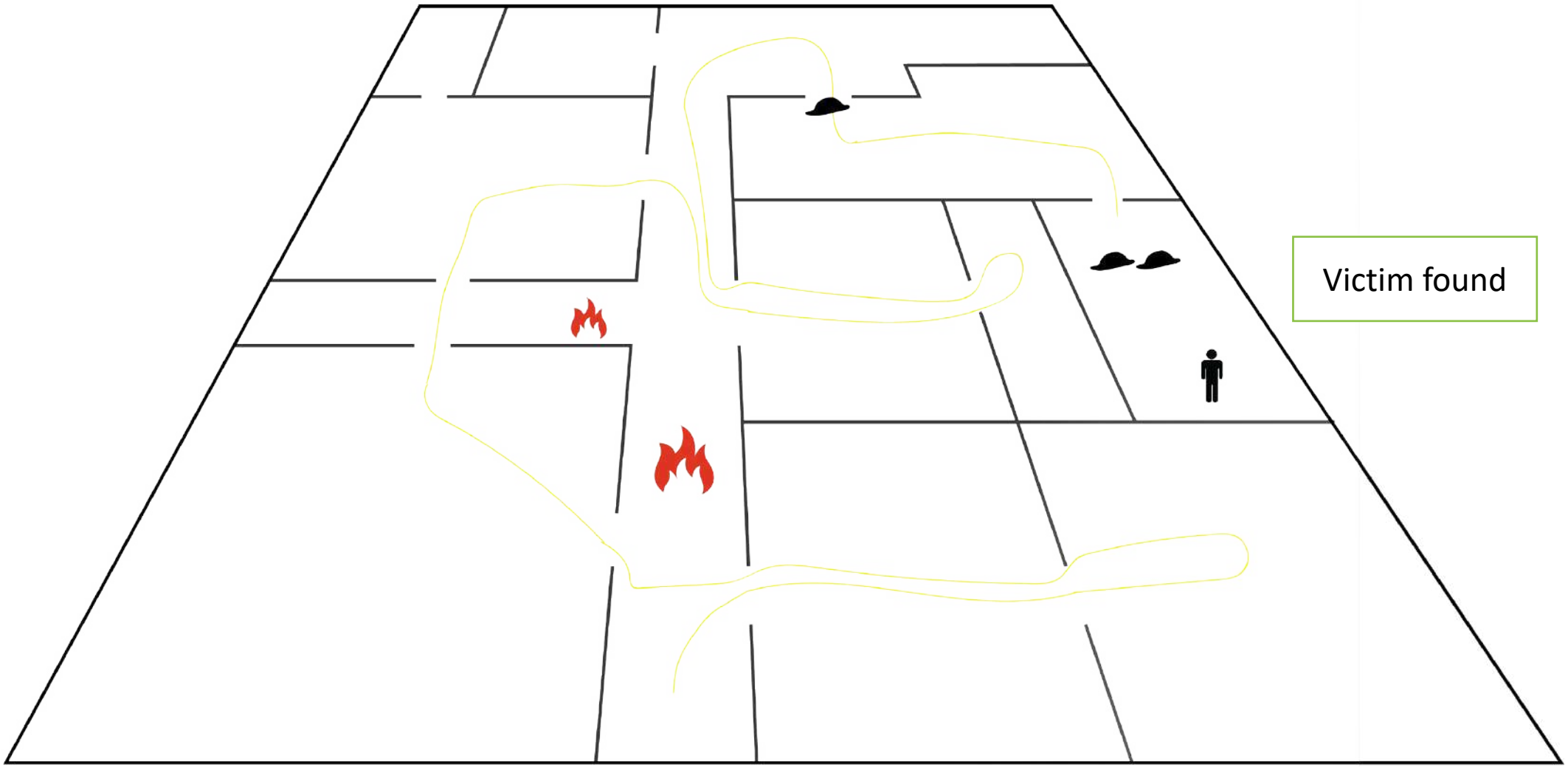

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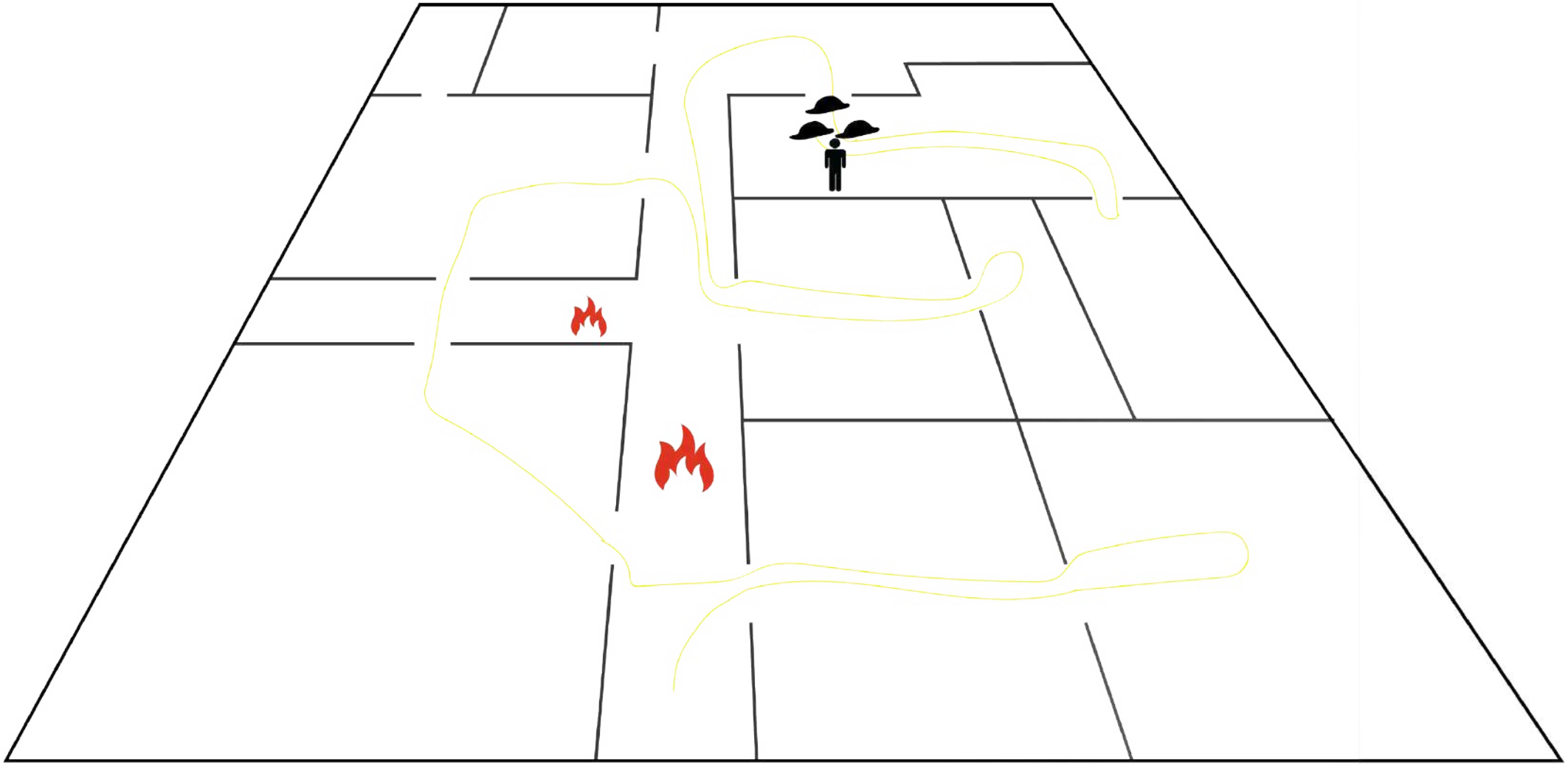

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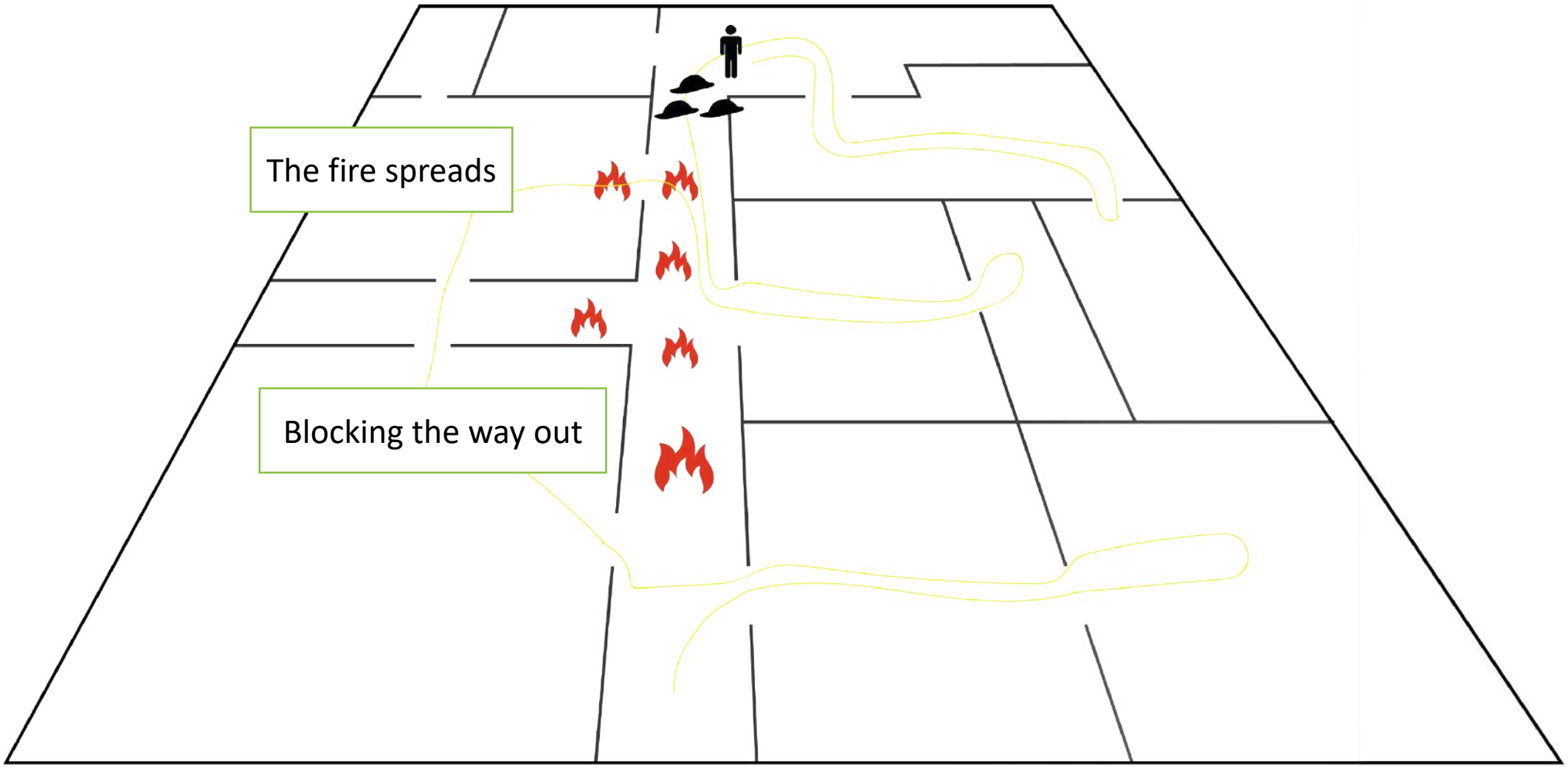
Dynamically generated floorplan



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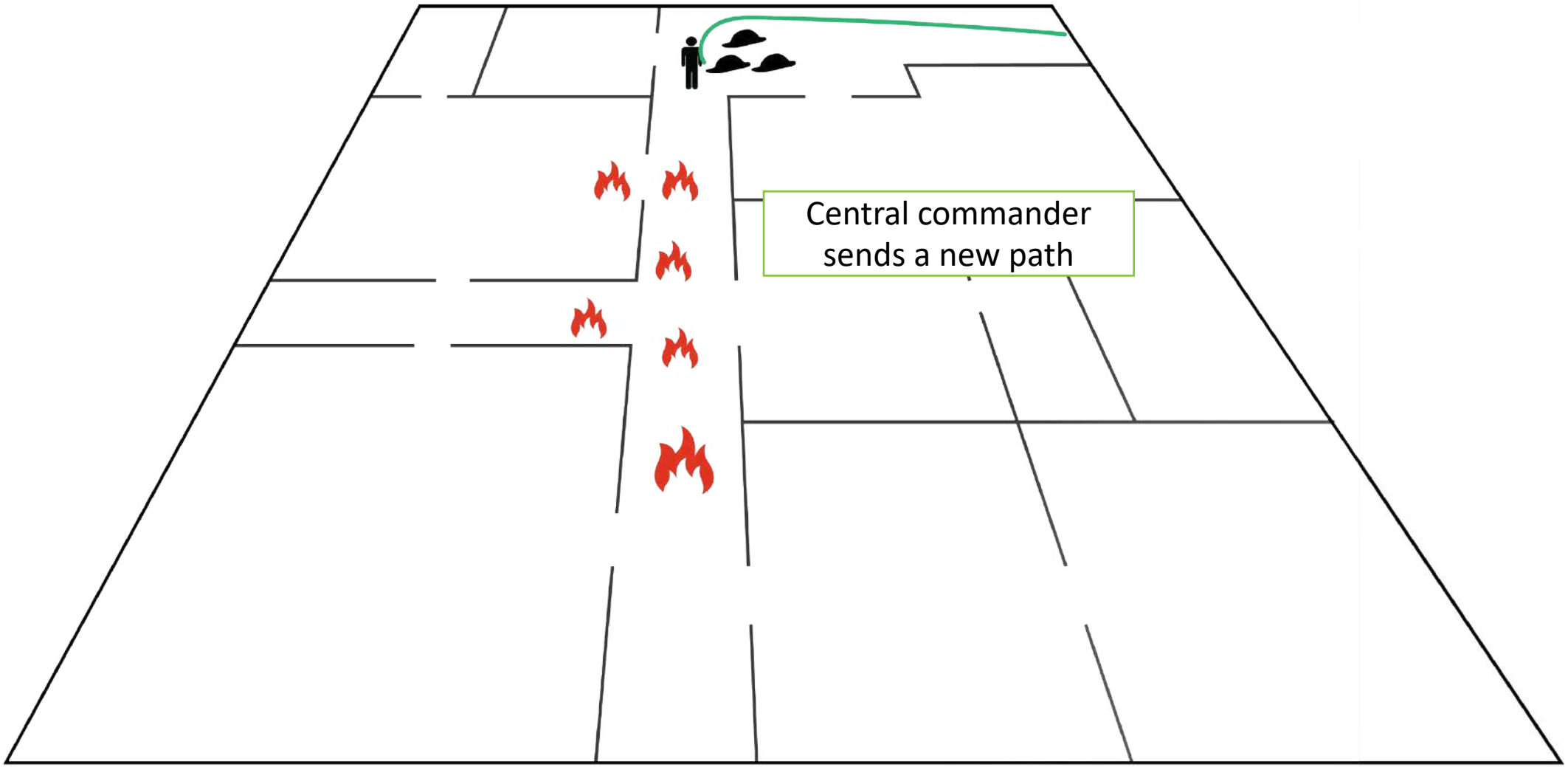

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Come back for the

Next Session