Building a repository of first responder-centered design resources:
Lessons learned from an early-stage pandemic project
Agenda

Introduction  Important Concepts  Project Objectives  Project Progress  Lessons Learned
NIST granted RTI $750,000 for 2 years of research through PSIAP: Public Safety Innovation Accelerator Program
RTI seeks to help innovators **build** in augmented reality
Important concepts
Augmented reality

Computer generated content overlays the physical environment

Real-time inputs create responsive, contextualized outputs
Not virtual reality
User-centered design

Involving users throughout the entire iterative design and development process
Usability

EFFECTIVENESS
Accuracy and completeness with which users achieve specified goals

EFFICIENCY
Resources (e.g., time, human effort, money and materials) used in relation to the results achieved

SATISFACTION
The extent to which the user's physical, cognitive and emotional responses that result from the use of a technology meet the user's needs and expectations

Usability is the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [ISO9241-11]
Learning experience design

LEARNING
- Philosophy
- Neurology
- (Cognitive) Psychology
- Experiential Learning
- Teaching
- Educational Expertise
- Instructional Design

EXPERIENCE

HUMAN
- Interaction Design
- User Experience Design
- Applied Game Design

DESIGN
- Game Design
- Industrial Design
- Graphic Design

GOAL
Driver/operator & pump panel

**Job position**

A firefighter who is trained to operate a pump panel

**Tool**

A device that provides the required water flow and pressure for a fire protection system
Project Objectives
FRAR Project
Deliverables

Published best practices:

- FR-CD methods in AR
- Assessment in AR
- Delivering educational materials in AR
- AR implementation readiness
FRAR Project Deliverable

Training module prototype (MVP 1)

The conversion of an idea into a concept with physical structure

Presented iteratively to learners to test its viability and validate assumptions

Definitions

- Master pump intake pressure gauge
  - This is connected to the intake side of the pump and measures both a positive pressure and a vacuum. It must be capable of reading 30 inches Hg (300 kPa) vacuum to at least a gauge pressure of 300 psi (2100 kPa). The gauge must be labeled as "Pump Intake."
- Master pump discharge gauge
  - This measures the pressure as it leaves the pump and is connected to the discharge side of the pump. It must be capable of reading from 0 to 300 psi (0 to 2100 kPa). This must be labeled as "Pump Discharge" and located within 8 inches of the master pump intake gauge and must be at least one inch larger than all of the other discharge gauges.
- Pumping engine tachometer
  - The tachometer is an instrument used for measuring rotational speed, defined as revolutions per minute (rpm) of the engine. The pump operator may reference the tachometer when troubleshooting any issue with the pump. If the psi does not match the rpm of the engine, the operator may recognize a problem with the pump and have to stop its operation.
- Pumping engine coolant temperature gauge
  - This allows the operator to monitor the temperature of the coolant inside of the engine of the apparatus. Too high, and it can cause severe damage to the engine and possibly cause it to shut down. Too low, and the engine may not operate as efficiently.
- Pumping engine oil pressure gauge
  - The engine oil pressure gauge indicates whether an adequate supply of oil is being distributed to the various areas of the engine. Different engines operate at different oil pressures, so the operator must be familiar with the normal operating range for the oil pressure.
- Voltmeter
  - The voltmeter measures the voltage across the battery terminals and gives an indication of the electrical condition of the battery.
- Pump pressure controls
  - The purpose of the pressure controls system is to control the discharge pressures, thereby protecting fire fighters who are operating hose streams as well as preventing damage to the discharge hose.
- Discharge Pressure Relief Valve
  - This controls the discharge pressure by passing water from the discharge side of the pump back into the intake side of the pump.
- Pump engine throttle
  - The pump operator needs to be able to increase or decrease the engine speed from the pump panel.
- Primer control
  - The primer control is used to expel any air that may be trapped inside the pump and during the starting operations.
FRAR Project
Deliverable

Persistent testbed

A “sandbox” or virtual software environment allowing for modular, monitored experimentation. Try changes without impacting real data or processes. Helps evaluate emerging protocols and applications and enumerate best practices.
FRAR Project
Deliverable

Best practices repository

A **centralized place** to store, maintain, and distribute data

Will hold a **catalog** of resources and recommendations for learning designers and application developers looking to create products for first responders
FR-AR Training: why this project is timely from my perspective
## FR-AR Training: why this project is timely from the user’s perspective

<table>
<thead>
<tr>
<th>ID</th>
<th>Quote</th>
</tr>
</thead>
<tbody>
<tr>
<td>FF-U-002</td>
<td>Every time we come to work, we have some kind of training component based on whatever we’re doing.</td>
</tr>
<tr>
<td>FF-R-009</td>
<td>I like where this department’s going with their vision right now. Training everybody and keeping track of them. You <strong>know</strong> where you’re at. So I think this department’s probably different than a lot of them in the perspective.</td>
</tr>
<tr>
<td></td>
<td><em>(Re: training requirements)</em> For example, we have to force doors. You can force one door in like 30 seconds. He wants to know if we train two hours on this, can you still force a door in 30 seconds? And a year later, if you don’t train do you lose that skill? No. So we can train on something else that does <strong>deteriorate over time</strong>.</td>
</tr>
<tr>
<td>FF-U-025</td>
<td>When I first came on the job, I got used to reading just gauges, right? Just focused on reading gauges and understanding those gauges. But when everything became computerized, touchscreen, and digital, that was a little complicating. So I think what it is is that you’ve just got to kind of <strong>evolve and learn</strong>, and there’s a lot of resistance to learn or to accept new changes….</td>
</tr>
<tr>
<td>FF-U-040</td>
<td>We have general training needs for the station. We’re constantly having to keep people progressing in their training to become apparatus drivers because people <strong>move on</strong> in their careers. The drivers that I’ve got now, over time, they get promoted and they go on to become unit officers. Well, then we need somebody in their position.</td>
</tr>
</tbody>
</table>
Project Progress
FRAR Project: timeline

- May 2021: Literature review
- August 2021: Fire site visit
- November 2021: Prototype MVP 1
- February 2022: Usability Testing
- May 2022: MVP 1 Testbed
- August 2022: Prototype MVP 2
- November 2022: Usability Testing
- February 2023: MVP 2 Testbed
- May 2023: Public Repository
FRAR Project: workflow

https://www.usability.gov/
Information sources

NIST Usability Results Tool, in-person site visit, YouTube, academic database, RTI Teams folder
<table>
<thead>
<tr>
<th>Code</th>
<th>Subcode</th>
<th>Discipline</th>
<th>Age</th>
<th>Experience</th>
<th>Gender</th>
<th>Transcript ID</th>
<th>Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training</td>
<td>FF</td>
<td>36-45</td>
<td>11-20</td>
<td>Male</td>
<td>PS-S-001</td>
<td>So, typically, on our rigs, you'll see, oh, there's only two people on your engine. Where there's the third person? Well, my third person is pushing a...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>36-45</td>
<td>11-20</td>
<td>Male</td>
<td>PS-S-001</td>
<td>--qualify and because we're truly public safety. So there's a lot of cross-training that happens. The EMS requirements are heavy, even at the basic...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>36-45</td>
<td>11-20</td>
<td>Male</td>
<td>PS-S-001</td>
<td>It's across the board. All of our guys--I mean, we utilize our online trainings and stuff. And we would have to sit in a classroom with a proctor...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>36-45</td>
<td>11-20</td>
<td>Male</td>
<td>PS-S-001</td>
<td>I mean, there's four or five cars are on their sides. We're doing auto extraction. I mean, the next day we're doing truck operations. So I get it...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>36-45</td>
<td>11-20</td>
<td>Male</td>
<td>PS-S-001</td>
<td>Whereas, well, is that real training? Is it valuable? Is it meaningful? Is it going to--is it realistic? And I think part of it is, okay, we're...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>36-45</td>
<td>11-20</td>
<td>Male</td>
<td>PS-S-001</td>
<td>But our POST standards, we have annual refresher and annual minimums that we need to meet. So, for example, everybody across divisions, all three,...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>36-45</td>
<td>11-20</td>
<td>Male</td>
<td>PS-S-001</td>
<td>So back to like--so some of the mandates are techno-based. So the county, through a grant through [City] Regional Public Safety Consortium, which...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>36-45</td>
<td>11-20</td>
<td>Male</td>
<td>PS-S-001</td>
<td>We had training the other day that our training officer, [Name]?, set up on a building that was going to come down. We trained on July 4th. No,...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>36-45</td>
<td>11-20</td>
<td>Male</td>
<td>PS-S-001</td>
<td>They contain more heat, but we're definitely more protected. There's also more awareness, I think, at this level, the company level, of, &quot;Hey, look,...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>18-25</td>
<td>5 or less</td>
<td>Male</td>
<td>FF-S-039</td>
<td>So a rescue squad is different than an engine or a truck in that our duties on a fire ground or an accident scene or another kind of rescue is a...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>18-25</td>
<td>5 or less</td>
<td>Male</td>
<td>FF-S-039</td>
<td>[RE: driving the heavy rescue vehicle] I'm working on my qualification for that now...It's more classes. It's more in-house training. We have a...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>18-25</td>
<td>5 or less</td>
<td>Male</td>
<td>FF-S-039</td>
<td>If we have an observer, I'll orient them. Make sure that they know where they're riding, what they need to do. Any inexperienced people, try to walk...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>18-25</td>
<td>5 or less</td>
<td>Male</td>
<td>FF-S-039</td>
<td>Sometimes, sometimes, we're not eating dinner until 11:00 PM, or sometimes we'll eat dinner at 7:00 and certain things change, right? But then once we get...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>18-25</td>
<td>5 or less</td>
<td>Male</td>
<td>FF-S-039</td>
<td>...The people who ride the rescue squad usually don't stop training right at 11:00. A lot of times well go till midnight or 1:00. Once we get in the...</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td>FF</td>
<td>18-25</td>
<td>5 or less</td>
<td>Male</td>
<td>FF-S-039</td>
<td>It varies because people ride a different amount, and people are in different stages of their training process. But right now we have...</td>
<td></td>
</tr>
</tbody>
</table>
First-Responder Centered Design I: identify need

Fire Apparatus Driver/Operators’ ability to execute sound **decision-making and judgement** dictates the forward progress of a fire incident.
Identifying needs: current limitations

Current training

- State standards from NC Department of Insurance Office of the State Fire Marshal
- Pump operations learned through mix of classroom instruction and tactile learning with the pump panel

Limitations identified

- Pump operations pass rate is unreliable for measuring performance
- Running a pump is expensive; outdoor environments are loud and distracting
- Cannot simulate rare incidents: D/Os are unprepared for untrained scenarios
- Knowledge, experience and hustle needed to establish a proper water supply
- Developing confidence and routine takes practice and patience
Identifying needs: potential opportunities

Realized technology opportunities

| FF:U:5440 | VR can be used in the fire service for training firefighters in decision-making in a safe environment. I lost a friend in a training fire and although lessons learned from his death will help will save others in the future, one lost life is not worth it. Harnessing VR can help reduce the risk of putting firefighters in a toxic environment for training. |
First-Responder Centered Design II: specify context of use

PERSONALITY

Helpful in high-stress situations
Calm under pressure
High level of integrity
Clear, open communicator
It just goes down to being there and doing it, getting the experience, and practicing. It takes practice, especially when you’ve got a lot of stuff or people on the scene yelling at you, “do this, do that, why aren’t you doing anything?” You got to remain calm but many incidents can be very overwhelming…initially.

I mean and even if they had just given us a cheat sheet. Cliff notes guide with pictures and words, and this is what we do, it would have been great. Yeah. I mean, I love having — well, if you look around at most of the firehouses that I’ve ever worked at, some of my notes are still up on the board because I don’t remember everything. I need reference points. So definitely training is huge.

Going after an incident too and use your phone, even as a learning tool. Look up, “Yeah, I could have done this”, or “Wow, I’ve learned something about this”. And again, it’s a great refresher of things. We have to again have so many skill sets in our possession, and technology allows us to go back through - our SharePoint system here - on some drills or again, “I forgot how to do this discipline or this maneuver”. You can always use it to benefit yourself and the others in the fire department. You can use the technology available at hand.
Context of Use: Firefighter Driver/Operators

**TECHNOLOGY ACCEPTANCE**

**FF-U-004**
Some of the older generations, a lot of them are retiring and we’re becoming a younger department again. So, a lot of these guys, they’re good with computers. The old guys, I’ve heard them complain about computers and stuff. The young guys are obviously more comfortable but on top of that, they haven’t ever had to learn how to do without it, so now that makes it even work because now they’re really dependent on that technology.

**EMT-S-6726**
I am too old to learn what our young EMTs use so easily. I have been active for 15 years and have been on more than 3,000 squad calls. Now that we are required to use computers for all reports, I am suddenly lost. I have taken workshops but find everything so difficult. I’m at a point of whether to quit volunteering anymore which saddens me.
<table>
<thead>
<tr>
<th></th>
<th>Volunteer</th>
<th>Career Driver Engineer</th>
<th>Trainer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
<td>18 year old male</td>
<td>37 year old male</td>
<td>69 year old male</td>
</tr>
<tr>
<td></td>
<td>Has a girlfriend</td>
<td>Married, father of two</td>
<td>Married</td>
</tr>
<tr>
<td></td>
<td>Soon-to-be HS graduate</td>
<td>B.S. in Electrical Engineering</td>
<td>Fire sector veteran</td>
</tr>
<tr>
<td></td>
<td><strong>Technology expertise</strong></td>
<td><strong>Physical characteristics</strong></td>
<td><strong>Psychological characteristics</strong></td>
</tr>
<tr>
<td></td>
<td>Twitch streamer</td>
<td>Passed the Candidate Physical Ability Test</td>
<td>Open to try new things</td>
</tr>
<tr>
<td></td>
<td>Completed a year of virtual high school</td>
<td>Really loves running up stairs</td>
<td>Questions existing approaches</td>
</tr>
<tr>
<td></td>
<td>High digital literacy</td>
<td></td>
<td>Challenges unacceptable behavior</td>
</tr>
<tr>
<td></td>
<td><strong>Motivations</strong></td>
<td></td>
<td>Identifies barriers to overcome</td>
</tr>
<tr>
<td></td>
<td>To help people in danger</td>
<td></td>
<td>Goal and focused under pressure</td>
</tr>
<tr>
<td></td>
<td>To be part of a supportive community</td>
<td></td>
<td>Sensation seeker</td>
</tr>
<tr>
<td></td>
<td>To learn as much as possible</td>
<td></td>
<td>Detail oriented</td>
</tr>
<tr>
<td></td>
<td><strong>Needs</strong></td>
<td></td>
<td>Takes on the responsibilities of a leader</td>
</tr>
<tr>
<td></td>
<td>Time to understand the responsibilities of being a FR/D/O</td>
<td>Extra practice on the pump</td>
<td>Seeks information about changing circumstances</td>
</tr>
<tr>
<td></td>
<td>Freedom to manipulate a D/O pump in a controlled, safe environment</td>
<td>To improve performance on the pump</td>
<td>Sensitive to students unique learning styles</td>
</tr>
<tr>
<td></td>
<td><strong>Common attributes</strong></td>
<td></td>
<td>Explores the ideas of others</td>
</tr>
</tbody>
</table>

**Driver/Operator training module user types**
First-Responder Centered Design III: specify requirements

**Primary learning objective**

D/O trainee comprehends pump panel components

**Knowledge dependencies** required to understand pump

Individual **knowledge base** up to pump panel training

Individual **state of mind** during pump panel training

**Considerations**

System assists with cognitive burdens

System bridges gap between user and comprehension

System delivers reasonable and understandable feedback

**Goals**

---

D/O Pumps: Intro and Basic Ops

FIP 3623
4 Skills Total


---

<table>
<thead>
<tr>
<th>Task</th>
<th>JFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Responding and Scene Tracking</td>
</tr>
<tr>
<td>2</td>
<td>Drifting from a Static Water Source</td>
</tr>
<tr>
<td>3</td>
<td>Connecting to Pressurized Water Source and Flowing Nozzles</td>
</tr>
<tr>
<td>4</td>
<td>Force Pumping</td>
</tr>
</tbody>
</table>
**Specifying requirements:** platform

AR as sufficient medium to **promote learning**

### Pedagogical contributions

- AR makes ‘boring’ instruction more **engaging**
- AR makes complex or abstract concepts ‘visible’
- AR can reduce learners’ **cognitive load** by displaying important information

### Learner outcomes

- AR increases learning performance
- AR enhances learners’ confidence through repetition
- AR enhances learners’ spatial ability
- AR promotes self-directed learning

### Challenges

- AR is unsuitable for large groups
- Headsets are uncomfortable
- Headsets are difficult to proctor
- Headsets are prone to technical difficulties
- Technology is still expensive
Specifying requirements: technological
Specifying requirements: monetary
<table>
<thead>
<tr>
<th>FF-R-051</th>
<th>Our chief is so-- I think he just got TVs in every firehouse so that we could use this training program so we could live feed training to a firehouse. They could pause it, go on a call and come back, hit play again and the training is up on the TV. He can talk to every firehouse if he wanted to and give a, &quot;Hey, I'm the chief. Here's the mission of the fire department. Here's the direction we're going in.&quot; And if they went on a call, they could just pause it and hit play again when they come back, they could finish watching him. I think it's even interactive. I think they can even ask questions back...</th>
</tr>
</thead>
<tbody>
<tr>
<td>FF-S-818</td>
<td>There is no replacing real experience. As the number of fires dwindle nationwide, I think our dumbed-down hyper-sterilized training has become a detriment to firefighters. It is no longer realistic and does not prepare us.</td>
</tr>
<tr>
<td>FF-R-019</td>
<td>It's all - everything in the public sector is about money. You have a limited supply of it. People think you don’t. My budget constantly goes down and my expenses go up and my needs go up. So I mean… that's where we're at.</td>
</tr>
<tr>
<td>FF-R-051</td>
<td>My long-range planning is really what I spend a lot of time on because it’s hard to determine, again, with our transient volunteers, again, through no fault of their own, what are their needs going to be. How do we need to make them successful in our organization? What classes are going to be available and at what cost? Classes are getting more and more expensive. We were just talking this morning. There is a class-- we’re getting our last guy through it, which as we've gotten everybody else through, was 100 bucks just to-- the tuition to get into class. That doesn't include the supplies, and hotel, and everything to get through it. But that class is now 500 bucks.</td>
</tr>
</tbody>
</table>

**Technological**

**Monetary**
First-Responder Centered Design IV: produce design solutions

Instead of introducing all this extra new stuff lets, one, make sure what we have actually works better. And then, two, let’s not rely on it so much.
Evaluate Designs

1. Identify Need
2. Specify Context of Use
3. Specify Requirements
4. System Satisfies
5. Produce Design Solutions
First-Responder Centered Design V: evaluate designs

SHORT-TERM
measure feature in solo usability or learning environment

LONG-TERM
systematic multi-feature evaluation in test bed environment
Measure D/O trainee’s comprehension of pump panel components.

Click on the component that matches the following name.

Click on the component that matches the following definition.
Evaluating designs: usability test plan

SCOPE: what is being tested, with whom, when, and with what equipment

PURPOSE: concerns, questions, and goals

TASKS: what participants will be doing

METRICS quantitative: how well participants performed

METRICS qualitative: how participants perceived their experience

1.0 Usability Testing Scope (In Scope – Out of Scope)

<table>
<thead>
<tr>
<th>In Scope</th>
<th>Out of Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>This testing protocol will focus on the Final Responsive Urban Water Relations (FRUR) concept that is being tested for the pump panel interface to improve its efficiency, productivity, and reliability.</td>
<td>This testing protocol will focus on other potential UI solutions.</td>
</tr>
<tr>
<td>This testing protocol will focus on enhancing the design for a single UI of urban water panel.</td>
<td>This testing protocol will focus on other potential UI solutions.</td>
</tr>
<tr>
<td>This testing protocol will focus on usability testing with participants from different backgrounds.</td>
<td>This testing protocol will focus on other potential UI solutions.</td>
</tr>
</tbody>
</table>

2.0 Usability Testing Assumptions and Constraints

Testing Assumptions

- Participants will be required to complete the protocol.
- Testers have access to the necessary equipment (e.g., simulation tools).
- Navigation and tree setup in application will be configured in test data.
- The questions and tasks listed under each usability test are not meant to be read-over rewritten versions.
- The observer should encourage the tester to think about how they are navigating the solution, not just to test the solution.

Usability Testing Constraints

- Adequate understanding of existing constraints and constraints introduced by proposed FRUR solution.
- Apparatus will be handled by testers only in the lab.
- Participants and test data collection will need to be consistent and reliable.
- There will be a maximum of 10 participants for each trial. The number of trials to be conducted will be determined by the project scope.

3.0 Usability Testing Tasks

- What participants will be doing:
  - Input data
  - Select pump panel
  - Use pump panel

4.0 Usability Testing Team Roles & Responsibilities

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Doe</td>
<td>FRUR R&amp;D – Technical Director</td>
<td>Provides oversight of the testing and testing plan.</td>
</tr>
<tr>
<td>Ashley Cage</td>
<td>FRUR Usability Testing Session Moderator</td>
<td>Provides summary of the testing schedule, guides usability testing, and provides feedback to participants on their performance.</td>
</tr>
<tr>
<td>Laura Martinez</td>
<td>FRUR Usability Testing Session Moderator</td>
<td>Provides feedback to participants on their performance.</td>
</tr>
</tbody>
</table>

5.0 Participating FR Information

<table>
<thead>
<tr>
<th>Name</th>
<th>Contact</th>
<th>Job Task</th>
<th>Comfort level with Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>User 1</td>
<td>Phone 1</td>
<td>Design Review</td>
<td>Medium</td>
</tr>
<tr>
<td>User 2</td>
<td>Email 2</td>
<td>Technical Support</td>
<td>High</td>
</tr>
</tbody>
</table>

6.0 Usability Testing Entry Criteria

<table>
<thead>
<tr>
<th>ID</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Before getting started, provide the participant with a brief overview.</td>
</tr>
</tbody>
</table>

7.0 Usability Testing Requirements-Based Test Cases

<table>
<thead>
<tr>
<th>ID</th>
<th>Test Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Observer to observe the appropriate scenario based on the FRUR’s rank and role.</td>
</tr>
<tr>
<td>2.0</td>
<td>Observer to observe the appropriate scenario based on the FRUR’s rank and role.</td>
</tr>
<tr>
<td>3.0</td>
<td>Observer to observe the appropriate scenario based on the FRUR’s rank and role.</td>
</tr>
</tbody>
</table>

8.0 Usability Testing (Use a think aloud approach)

<table>
<thead>
<tr>
<th>ID</th>
<th>Test Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Observer to observe the appropriate scenario based on the FRUR’s rank and role.</td>
</tr>
</tbody>
</table>

FRUR FRCD Testing Protocol

Before completing the Test Cases, the FRUR must complete a pre-test demographic and background information questionnaire. The FRUR must then do the hands-on front-end usability checklist to ensure that their assigned Test Case matches the FRUR’s role. The test will consist of a pre-test questionnaire and a checklist on the task with the facilitator following each Test Case.
Evaluating designs: usability test plan metrics

**Successful task completion**
Completed task goal (matched pump panel component)

**Non-critical error**
Inefficiently completed task goal

**Critical error**
Did not complete task goal

Types of metrics tested
Performance, time on task, accuracy, #/% of tasks completed, learning rate
Evaluating designs: example usability scales

Table 2: The HAR Usability Scale

<table>
<thead>
<tr>
<th>Manipulability Measures:</th>
<th>Relevance to HAR:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think that interacting with this application requires a lot of body muscle effort.</td>
<td>HAR is often used while moving around the real environment.</td>
</tr>
<tr>
<td>I felt that using the application was comfortable for my arms and hands.</td>
<td>HAR strains the hands and arms the most.</td>
</tr>
<tr>
<td>I found the device difficult to hold while operating the application.</td>
<td>HAR has grip and pose issues.</td>
</tr>
<tr>
<td>I found it easy to input information through the application.</td>
<td>HAR introduces novel interaction metaphors.</td>
</tr>
<tr>
<td>I felt that my arm or hand became tired after using the application.</td>
<td>HAR strains the hands and arms the most.</td>
</tr>
<tr>
<td>I think the application is easy to control.</td>
<td>HAR introduces novel interaction metaphors.</td>
</tr>
<tr>
<td>I felt that I was losing grip and dropping the device at some point.</td>
<td>HAR has grip and pose issues.</td>
</tr>
<tr>
<td>I think the operation of this application is simple and uncomplicated.</td>
<td>HAR introduces novel interaction metaphors.</td>
</tr>
</tbody>
</table>

Comprehensibility Measures:

<table>
<thead>
<tr>
<th>I thought that interacting with this application requires a lot of mental effort.</th>
<th>Relevance to HAR:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I thought the amount of information displayed on screen was appropriate.</td>
<td>HAR is susceptible to presenting too much information on a small screen.</td>
</tr>
<tr>
<td>I thought that the information displayed on screen was difficult to read.</td>
<td>HAR introduces novel visualization metaphors.</td>
</tr>
<tr>
<td>I felt that the information display was responding fast enough.</td>
<td>HAR has legibility issues due to ambient light, glare, etc.</td>
</tr>
<tr>
<td>I thought that the information displayed on screen was confusing.</td>
<td>HAR has latency issues due to the limited processing power and network connection.</td>
</tr>
<tr>
<td>I thought the words and symbols on screen were easy to read.</td>
<td>HAR introduces novel visualization metaphors.</td>
</tr>
<tr>
<td>I felt that the display was flickering too much.</td>
<td>HAR has legibility issues due to ambient light, glare, etc.</td>
</tr>
<tr>
<td>I thought that the information displayed on screen was consistent.</td>
<td>HAR is susceptible to tracking and registration errors due to many factors, such as dynamics of lighting.</td>
</tr>
</tbody>
</table>

Mental & Emotional States

- FRU - Indication of frustration / dislike
- SUGG - Child makes suggestion
- CONF - Indication of confusion
- BOR - Indication of boredom
- AHA - Indication of "aha" moment
- TIRV - Indication of physical tiredness
- SPACEEV - Indication of 3D space awareness

General Movement

- SCRATCH - Interrupts game to screen
- HSTR - Fingers / hand / arm stretched
- HSHAKE - Hand shaken
- BSTR - Body stretching
- BSSIT - Body sitting down
- ELT - Elbow or hand is resting on table
- PHONEDROP - Phone dropped or slips
- PHONEDOWN - Puts the phone down
- BUMP - Bumps or hits body
- BSW - Back has switched its posture

Help and Interruptions

- HLPME - Child asks for help
- HLPVR - Experimenter gives quick help
- INTN1 - Gameplay interrupted while experimenter helped for a period of time, just verbally
- INTN2 - Gameplay interrupted while experimenter helped for a period of time, and took away the phone / moved the paper / or touched the child
- IGN - Child ignored instructions from the game or experimenter

INT - Child did something which caused their gameplay to be interrupted (e.g., looking at experimenter)

Tracking Events

- TLW - Tracking lost while walking
- TLF - Tracking lost, finger occlusion
- TLA - Tracking lost, aiming away
- TLC - Tracking lost, too close

Grips

- GSW - Hand has switched its grip
Evaluating designs: measuring learning

Control group: receive standard textbook lecture & PowerPoint on pump panels

Treatment group: receive first responder augmented reality pump panel intervention

Between-subject: measure difference among groups on same test identifying components

Within-subject: measure difference among student receiving control then AR intervention
First-Responder Centered Design VI: system satisfies
Thoughts on implementation: CFIR

Facilitators

An *early adopter*
Technology support
Management support
Resource support
Policy support
Project complexities: RTI FRAR team

- Building a common vocabulary
- Remote work challenges
- Emerging domain
- Time management with UNC course load
- Overcoming leadership gaps
- Extremely specialized domain
Defining the problem

1. Defining the problem
2. Envisioning the desired end state (knowing what victory looks like)
3. Defining the approach by which victory can be achieved
4. Inciting support and then action

Innovating

5. Seeking insight to inform the prototyping of the solution
6. Prototyping potential solutions
7. Delineating the tough choices
8. Enabling the team to work as a team

Generating value

9. Choosing the best solution then activating it
10. Making sure people know about your solution
11. Selling the solution
12. Rapidly learning and “tacking” based on your successes and failures
Questions?

mom can you come pick me up? I'm at the intersection of art & technology