Bus Driver Display

HARMONIOUS BUSICYLES

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ENP161

Why?

- We aim to mitigate bus-cyclist collisions
- 818 cyclists killed in motor vehicle traffic crashes [1]
- 45,000 cyclists injured [1]
- Driver & rider error was the most frequently reported reason for accidents (71% of all reported accidents in 2016) [2]

1: NHTSA. (2018). Traffic Safety Facts.
2 :ROSPA. (2017). *Road Safety Factsheet.*

Overview

Identify

- Observational Study
- Competitive Analysis
- Wireframes and initial designs
- Identified user needs and requirements
- Task Analysis
- Risk Assessment

Design, Verify & Validate

- Designed prototype
- HF design standards
- Usability test
- Next steps

User needs and requirements

1

Alerts must be **visible** and **audible** and distinguishable from other alerts from within the bus I,

2

Alert must be audible and **distinguishable** from other auditory alerts from within the bus.

3

Alerts must be placed in the driver and passenger side mirrors to increase the **visibility** and access to the driver.

4

Alerts must be capable of **detecting** cyclists in from the busses known blind spots.

5

Alerts must be positioned within the drivers range of **peripheral** view.

Task Analysis

- Cognitive Task Analysis; hierarchical TA less applicable
- Constantly assessing & adjusting actions
- Focused on obstacle detection step

Table 1.

Task Step	What decisions are being made?	How are you making the decision?	What information is required to make the decision?	How do you process the information? (think about the information / what do you do with the info?)	Criteria for completion
Obstacle detection	Which items may be obstacles	determining threat level of obstacle, collision	size, shape, velocity and location of object relative to you	identify object, rely on past experience to predict objects movement	no obstacles hit

Risk Assessment

Scenario : Cyclist in the drivers blind spot while the bus changes lanes **with and without our product**

Risk Identification

- Hazards in public transport[1]
- Falling asleep
- Mental overload

Results of Analysis

- **‘No alert’ condition risk level is unacceptable.**
- **‘With alert’ risk, level is manageable.**

1: Milošević, A., & Nedeljković, S. (2016). Act On Risk Assessment For The Bus Driver Workplace With Measures Of Health And Safety At Work. Horizons

HF Standards

1. Easily perceivable and discriminable colors for thick lines and area
2. Visible colors for different viewing angles

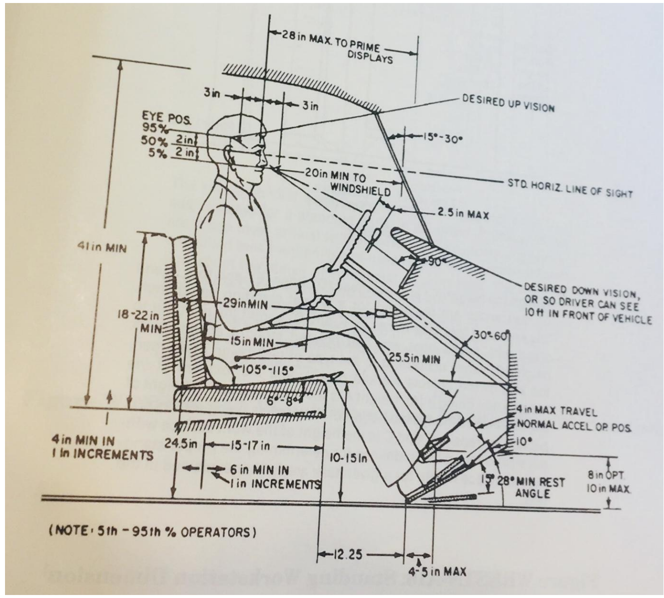
Table 2. Visible Colors For Different Viewing Angles [1]

Peripheral viewing	Red	Blue	Green	Cyan	Magenta	Yellow
0-40 degrees	X	X	X			X
40-50 degrees		X				X
50-60 degrees		X				
>60 degrees						

1:*Discernible Color For Drivers' (Campbell, et al., 2016)*

Design Decisions

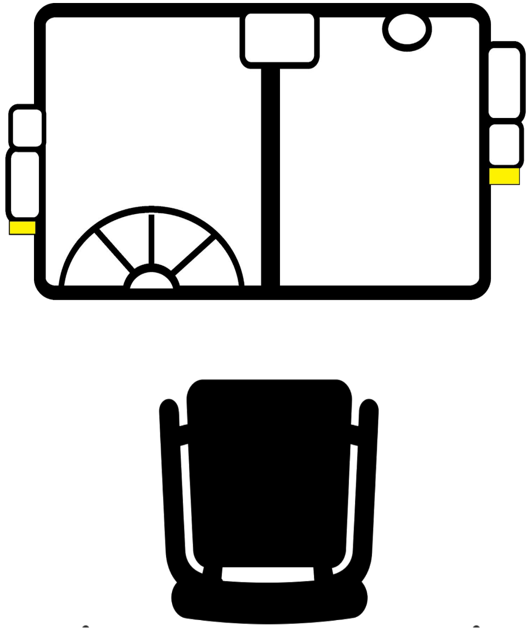
- Buzzer placement -> head circumference: btwn. two ears approx. 7 inches
- Accommodate drivers range of movement, maintain optimal ergo. position
- Auditory alert -> CycleEye system: nonverbal sounds more effective in alerting drivers
- Ears, unlike our eyes, can receive information from all directions” Chapanis (1967)
- Yellow light -> Ease of alert perception per HF standards



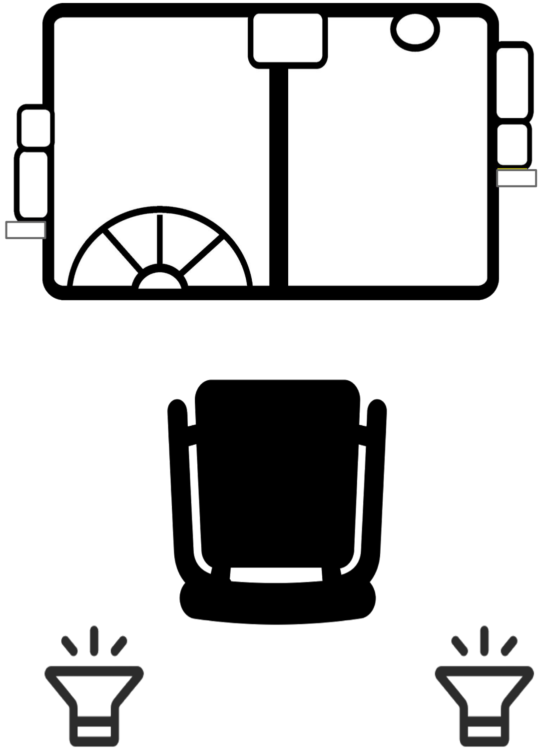
1: *Ngugen et. al., (2018)*
2:

Wireframe Sketches

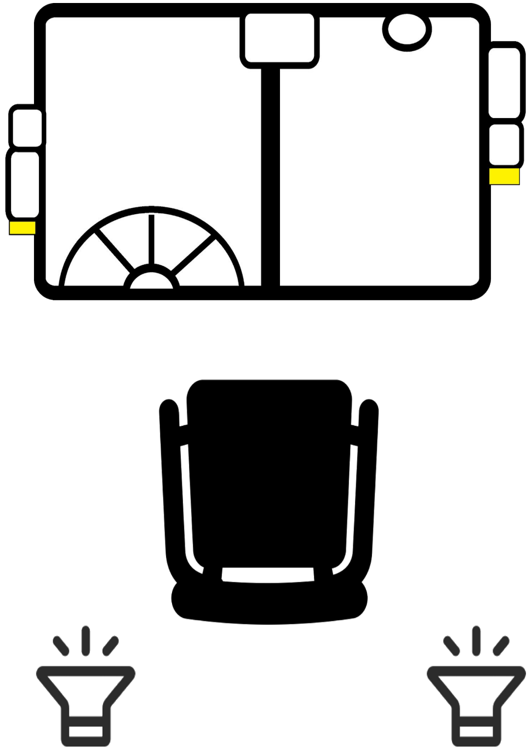
- Auditory



- Visual



- Both



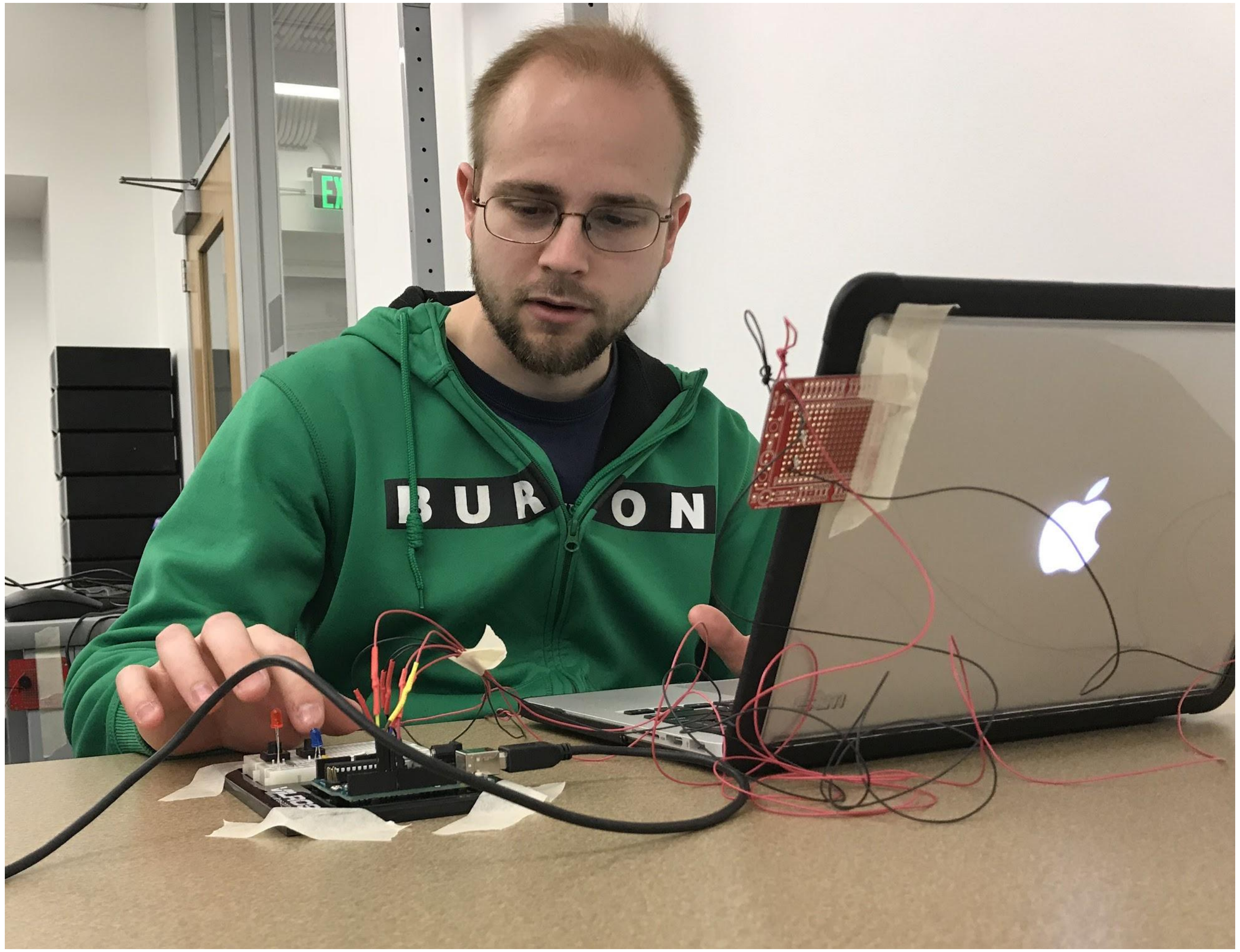
Prototype Design

- laptop with driving video
- light alerts on sides of screen

- sound alerts behind participant
- L & R response buttons

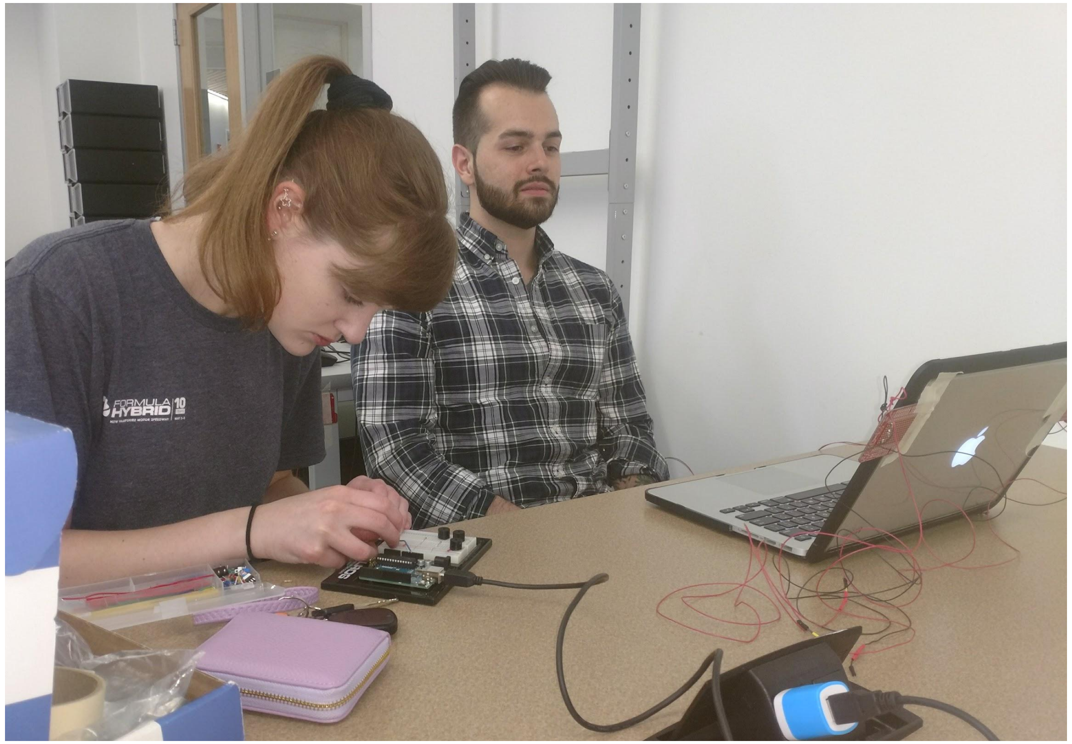
Experimental Design

1. Participants told to pretend they are driving a bus
2. Sound, light or combined alerts will go off during the video
3. When alert goes off, participant must push left or right button to identify alert



NASA TLX to Measure Workload

Experimental Design



Name	Task	Date

Mental Demand — How mentally demanding was the task?

Very Low — Very High

Physical Demand — How physically demanding was the task?

Very Low — Very High

Temporal Demand — How hurried or rushed was the pace of the task?

Very Low — Very High

Performance — How successful were you in accomplishing what you were asked to do?

Perfect — Failure

Effort — How hard did you have to work to accomplish your level of performance?

Very Low — Very High

Frustration — How insecure, discouraged, irritated, stressed, and annoyed wereyou?

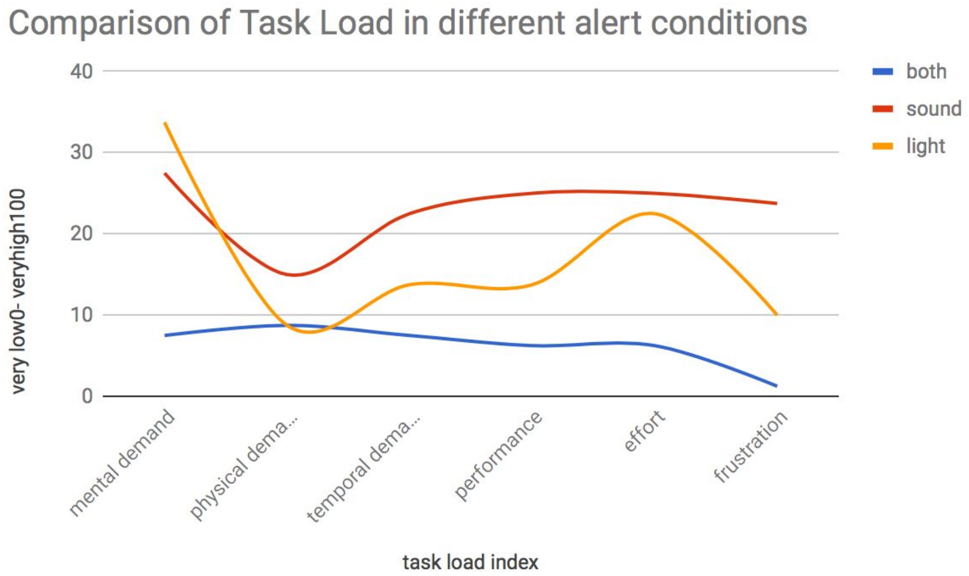
Very Low — Very High

Results

Participant	Age/ gender	Drive experience	System	Hit sequence	Observation
1	23/F	no	both	r-l-l-r-l-r-r	Sound says must click, Light says which side
2	21/F	yes	both	r-l-l-r-l-r-r	Cannot tell the direction of sound
3	21/F	yes	sound	r-l-l-r-l-r-r	
4	24/M	yes	sound	r-l-l-r-l-r-r	
5	25/M	yes	light	r-l-l-r-l-r-r	
6	62/F	yes	light	r-l-l-r-l-r-r	
7	24/M	yes	both	r-l-l-r-l-r-r	Cannot tell direction of sound
8	22/F	yes	light	r-l-l-r-l-r-r	
9	21/M	yes	sound	r-l-l-r-l-r-r	
10	21/F	yes	sound	r-l-l-r-l-r-r	
11	22/M	yes	light	r-l-l-r-l-r-r	
12	23/F	yes	both	r-l-l-r-l-r-r	Cannot tell direction of sound

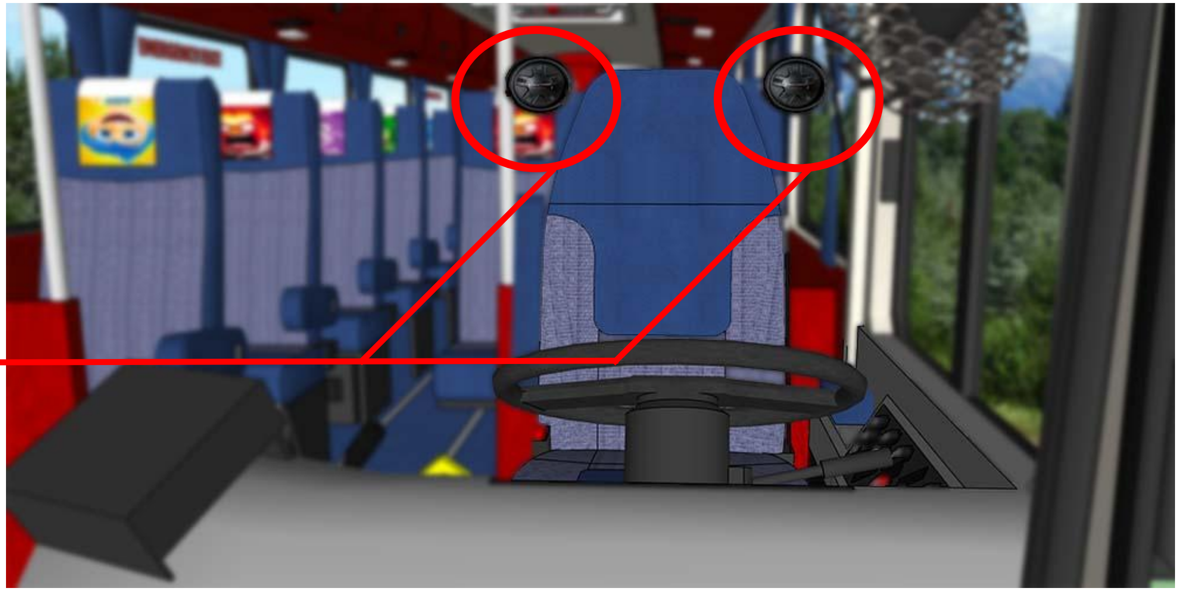
TLX Results - Light and Sound Both

Participant	Mental Demand	Physical Demand	Temporal Demand	Performance	Effort	Frustration
1	10	20	10	0	5	0
2	5	5	15	20	15	0
7	15	5	5	5	5	5
12	0	5	0	0	0	0
Average	7.5	8.75	7.5	6.25	6.25	1.25



Refined design

Stereo Speaker



Light Alert

Next Steps

- Different ‘both visual & auditory’ alert conditions
- Light colors
- Sound frequency
- Number of auditory alerts
- Test in a bus simulator
- Test on a real bus

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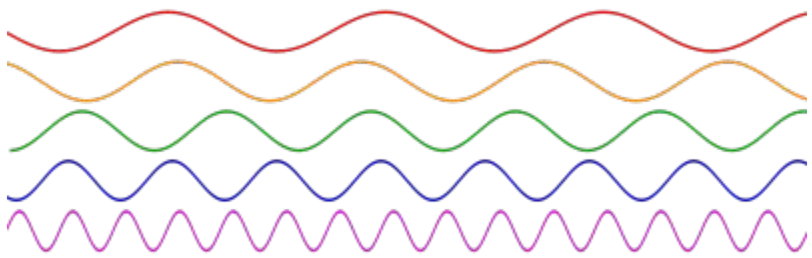

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Thank you, Q&A