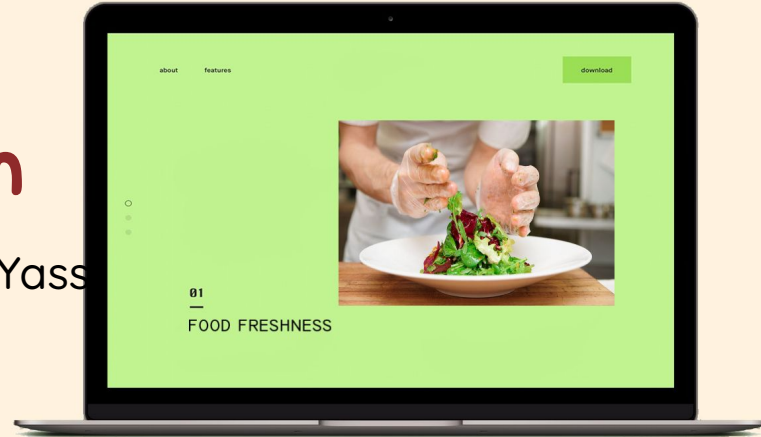


Design Review 2: Food Freshness Team

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14 March 2022



Problem Statement


A way to accurately and efficiently determine the level of freshness of meat products to improve sanitary and health concerns for at-home cooks and ultimately reduce food waste.



Intended User

- At-home every day cooks
- Main concerns
 - Food safety
 - Food waste
 - Affordability
- Product can be used by **anyone**
 - Little/no interpretation required
 - Clear indicator
 - Accessibility





Design Process

Project Plan Progress

Phase 2: Design Inputs and Specifications (Yassi)								
2	Phase 2: Design Inputs and Specifications (Yassi)			0%	2/21/22	2/27/22		
2.1	Design Selection		All	0%	2/21/22	2/27/22		
2.1.1	Brainstorm Potential Solutions		All	0%	2/21/22	2/27/22		
2.1.2	Concept Selection		All	0%	2/25/22	2/27/22		
2.1.3	Submit HWK T4		JP	0%	2/27/22	2/27/22		
2.2	Design Inputs		YK, AD	0%	2/25/22	3/7/22		
2.2.1	Submit HWK T5 draft		YK	0%	2/25/22	3/2/22		
2.2.2	Update Design Inputs		All	0%	3/2/22	3/7/22		
2.2.3	Submit HWK T5		AD	0%	3/4/22	3/7/22		
2.3	Finalize Acceptance Criteria		CR	0%	2/25/22	2/28/22		
2.4	Initial Product Sketches & Design Model		Paper, whiteboard	All	0%	2/28/22	3/2/22	
Phase 3: Design Process and Outputs								
3.1	Revised Product Drawings		All	0%	3/2/22	3/7/22		
3.2	CAD Prototype, Arduino (if applicable)		SolidWorks	AD	0%	3/7/22	3/13/22	
3.3	Usability/Risk Analysis		JP, AD	0%	3/2/22	3/14/22		
3.3.1	Submit Draft		YK	0%	3/2/22	3/9/22		
3.3.2	Update risk analysis		All	0%	3/9/22	2/14/22		
3.3.3	Submit Final		JP	0%	3/9/22	3/14/22		
3.4	Prepare Design Review 2		Presentation deck	AD	0%	3/7/22	3/14/22	
3.5	Initial Order List			JP	0%	3/9/22	3/16/22	
3.5.1	Identify Specifications			AD	0%	3/9/22	3/13/22	
3.5.2	Cost Analysis and Manufacturing Considerations			JP	0%	3/13/22	3/16/22	
3.6	Prototype Construction		3D printer	JP	0%	3/13/22	3/23/22	
3.7	Design Verification			CR	0%	3/16/22	3/26/22	
3.7.1	Acceptance Criteria Testing		Food item to test	CR	0%	3/16/22	3/19/22	
3.7.2	Input/Output Verification			CR	0%	3/19/22	3/23/22	
3.8	Revise Prototype			All	0%	3/23/22	3/30/22	
3.9	Update Traceability Matrix			YK	0%	3/23/22	3/26/22	

- Phase 3
- Key milestones
 - Concept Selection
 - Design Inputs
 - Early Prototyping

Concepts



Container



Strips/swabs



Probe



Companion Ball



FoodSniffer 2.0



Mass spectrometry?

Pugh Matrix

Item No.	Name	Description	Easy and Safe for People with Physical Disabilities (Artem)	Compact/Easy to store	Travels well	Accuracy of Freshness Detection	TOTAL
1	Food container with built-in multifunctional temperature and timing tracker	Displays graph of temperature over time and estimates risk of spoilage (or time left at current temperature) with non-linear estimation based on recorded temperature	3	3	3	3	74.5
1.1		Container with only temperature sensing capabilities	3	3	3	2	75.5
1.2		Container with only timing capabilities	3	3	3	1	73.5
		Container with fine moisture level sensing	3	3	3	3	71.5
1.3		Bag with temperature and/or timing capabilities	2	4	3	2	70
2	pH detector strips/swab	A single-use strip or swab capable of detecting food freshness using pH sensing capabilities by swabbing the surface of the food	2	5	5	3	67.5
2.1		Moisture Sensing	2	5	5	3	65.5
2.2		Bacteria Sensing	2	5	5	3	64.5
2.4		Probe (reusable) version	4	4	4	3	81
3	UV based high resolution scanner device	Device/phone lens with high resolutions scans/takes picture of food item's surface and detects bacteria present, uses image detection to classify bacteria.	2	3	3	2	67.5
4	Gas Sensing and Analyzing Device	Handheld device able to scan food and determine food's freshness by gasses omitted by the food	4	3	2	3	75.5
5	Phone apps	Downloadable app used on a smart phone used to image food to detect food's freshness	-	-	-	-	-
5.1		Time tracking only	5	5	5	1	91.5
5.2		With special lens for fine color sensing of the phone's lens for color sensing	3	5	5	2	77.5
6	Smart fridge/system	Fridge that tracks how long each item has been in it through temperature-dependent spatio-temporal mapping	5	1	1	2	70.5
7	Mini mass spectroscopy device	Complete compositional breakdown of meat, identification of any harmful substances (bacteria, chemicals, etc.	2	2	2	5	54
8	Freshness-sensitive Companion Ball	A small 3D ball that can be placed in any kind of bag or container that is able to sense the food's freshness. Provides feedback by changing color	-	-	-	-	-
8.1		Temperature	5	4	4	3	78

Concept Selection

- Key Criteria
 - Feasibility
 - Ease of use
 - Reusability
 - Fast, minimally invasive, accurate
- Highest Scoring Concepts
 - Bacteria/Moisture Probe (81)
 - Phone app (91.5)
 - Temperature companion ball (78)
- Rethinking selection criteria →
Time/Temperature Sensing Container

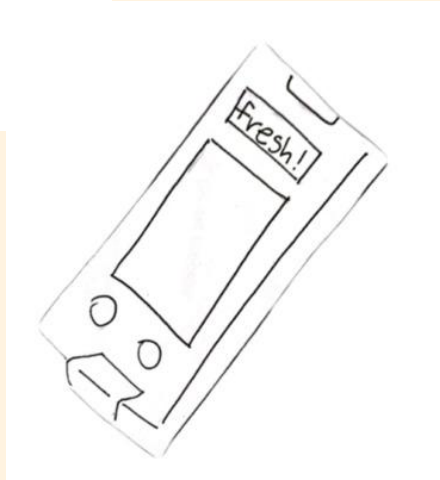
Probe (reusable) version	Same as items 2-2.3 however reusable and able to be stuck into the food rather than just the surface
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Phone apps		Downloadable app used on a smart phone used to image food to detect food's freshness
	Time tracking only	User inputs expiration date of food product, and app provides reminders when the food is about to spoil and when

Freshness-sensitive Companion Ball		A small 3D ball that can be placed in any kind of bag or container that is able to sense the food's freshness. Provides feedback by changing color
	Temperature	Only temperature dependent

Food container with built-in multifunctional temperature and timing tracker		Displays graph of temperature over time and estimates risk of spoilage (or time left at current temperature) with non-linear estimation based on recorded temperature
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Sketches



- Container with Arduino lid for time and temperature detection
- Two buttons for reset and start
- Two different display ideas: red-yellow-green stoplight and word/smiley face display

Key Design Inputs

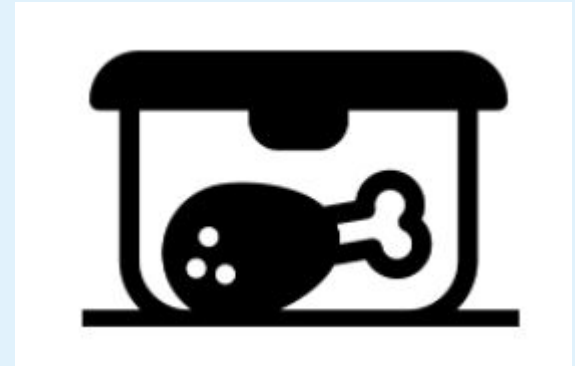
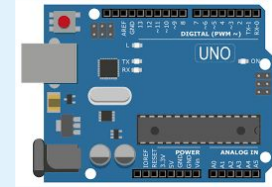
Product Performance Requirements (e.g.Mechanical)				
Reusable	2.1.1	Can be used repeatedly for 2 years without breaking or losing function.	3 years	2 years
	2.1.2	Restart button to reset freshness monitoring.		
Minimally invasive to food product	2.2.1	Contact area, if any, should be below 1 cm ²	0.5 cm ²	1 cm ²
	2.2.2	Penetration depth should be inversely proportional to contact area. The larger the contact area, the less deep it should penetrate		
Rapid result feedback		Should take as long as a normal digital thermometer would: 40 seconds	30 seconds	1 minute
Functional at freezing temperatures		Fully functional and physically/chemically safe at temperature range 32° F - 100° F	0° F - 100° F	32° F - 100° F
Water resistant, dust protected		Meets Ingress Protection Code IP55 standard.		
	2.5.1	Level 5: Dust protected		
	2.5.2	Level 5: Water jets		
Wireless	2.6.1	Commercially available replaceable battery		
	2.6.2	Battery lasts for a minimum of a month.	5 weeks	2 weeks
	2.6.3	Battery is no larger than 2cm x 2cm x 4cm.	1.5cm x 1.5 cm x 3cm	2.5 cm x 2.5 cm x 4.5 cm

Key Design Inputs

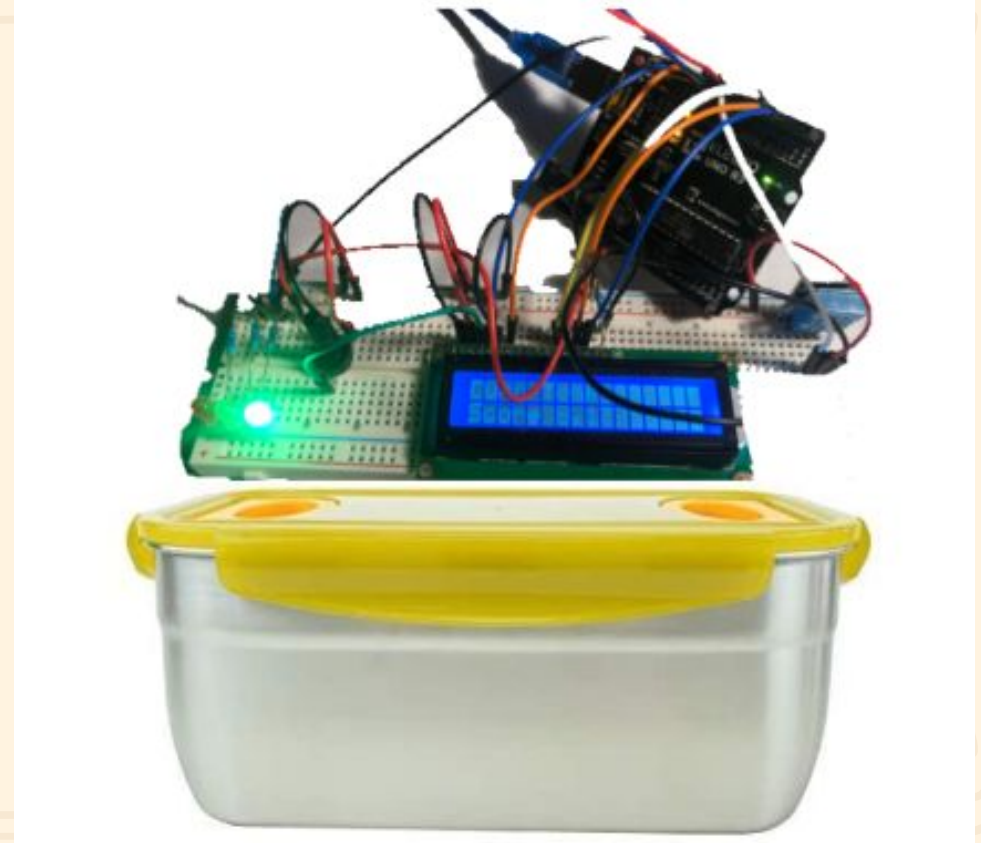
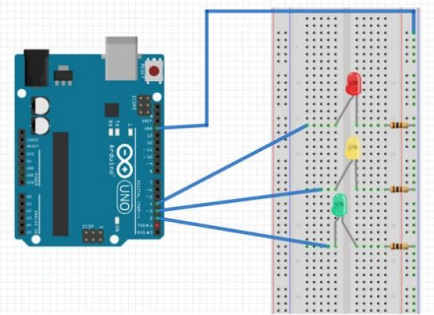
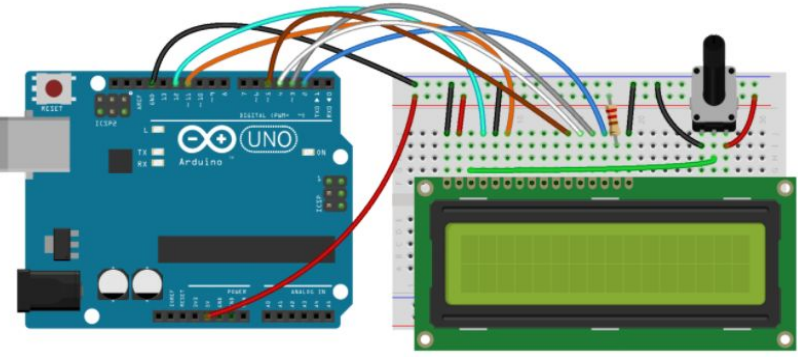
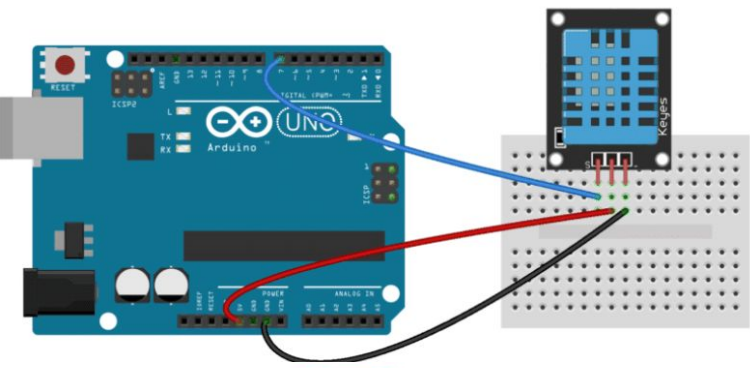
Customer Requirements (e.g. Functional)			Ideal	Limit
Evaluates meat product freshness/spoilage	1.1.1	Accuracy of temperature measurement (sensor sensitivity) 99%	99%	95%
	1.1.2	Records temperature fluctuation within the container when temperature changes for at least 0.2 °C after 1 minute time increment	0.2	0.5
	1.1.3	Stops recording as soon as product reaches spoilage stage		
	1.1.4	1MB memory, can store 125,000 datapoints, about 87 sampling days if sampling every minute.	90 days	45 days
Intuitive for an average consumer to use with little or no instruction	1.2.1	Device comes with clear instructions		
	1.2.2	Only three buttons	2 buttons	4 buttons
	1.2.3	User can understand how to use device in less than 5 minutes	3 mins	7 mins
Compact and fits in common family food storages	1.3.1	Total volume doesn't exceed 20cm x 20cm x 20 cm		
Simple visual feedback of spoilage risk	1.4.1	Digital interface capable of outputting 3 statuses based on sensor input, smiley face for fresh, neutral face for starting to spoil, and frowning face for spoiled		
	1.4.2	Sensitivity and specificity of spoilage status estimation	99/99	95/90
Cost is less than value of saved food over lifetime		Device cost is at most \$30	\$25	\$35
Easy to clean		Material XXX		
		Can be put through dishwasher 100 times	Withstands 150	Withstands 100

Design Features

- Container design for food storage
- Records temperature fluctuations
 - 0.2 °C after 1 minute time increment
- Visual output for user
 - Fresh, starting to spoil, and spoiled
- 1MB memory
 - 87 sampling days (sampling every minute)
- Battery lasts for a minimum of a month



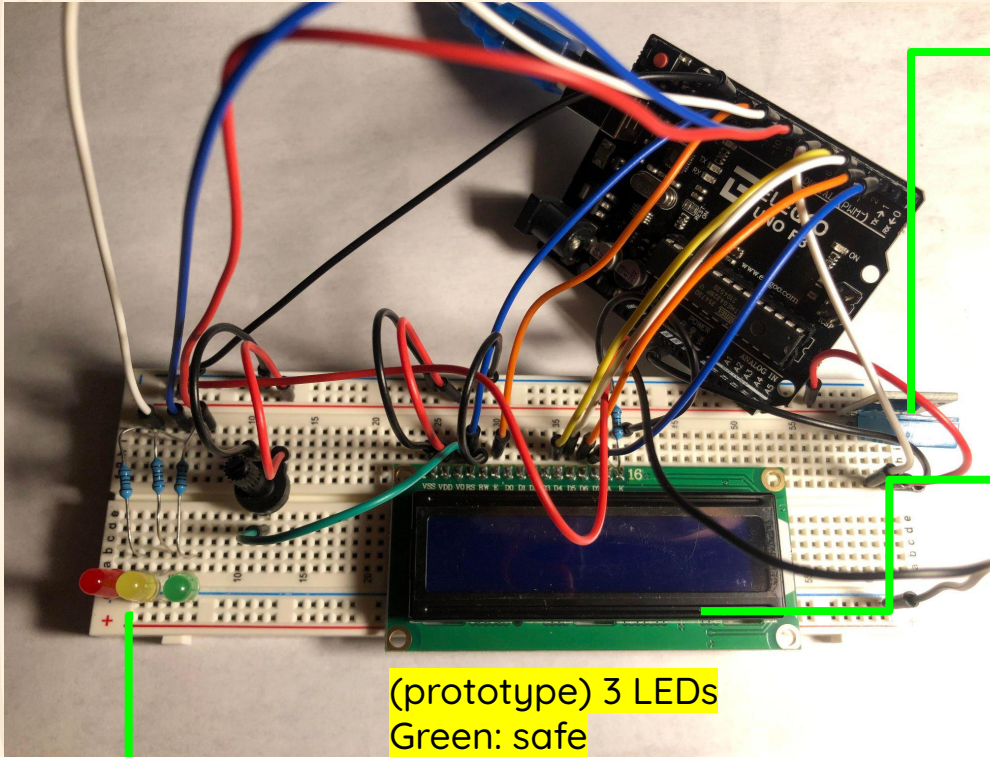
Prototype



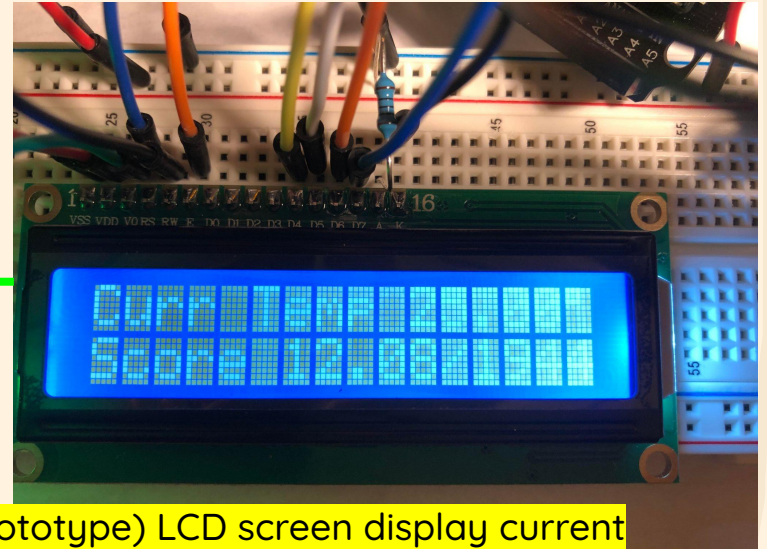
Prototype



Temperature Sensor DHT11

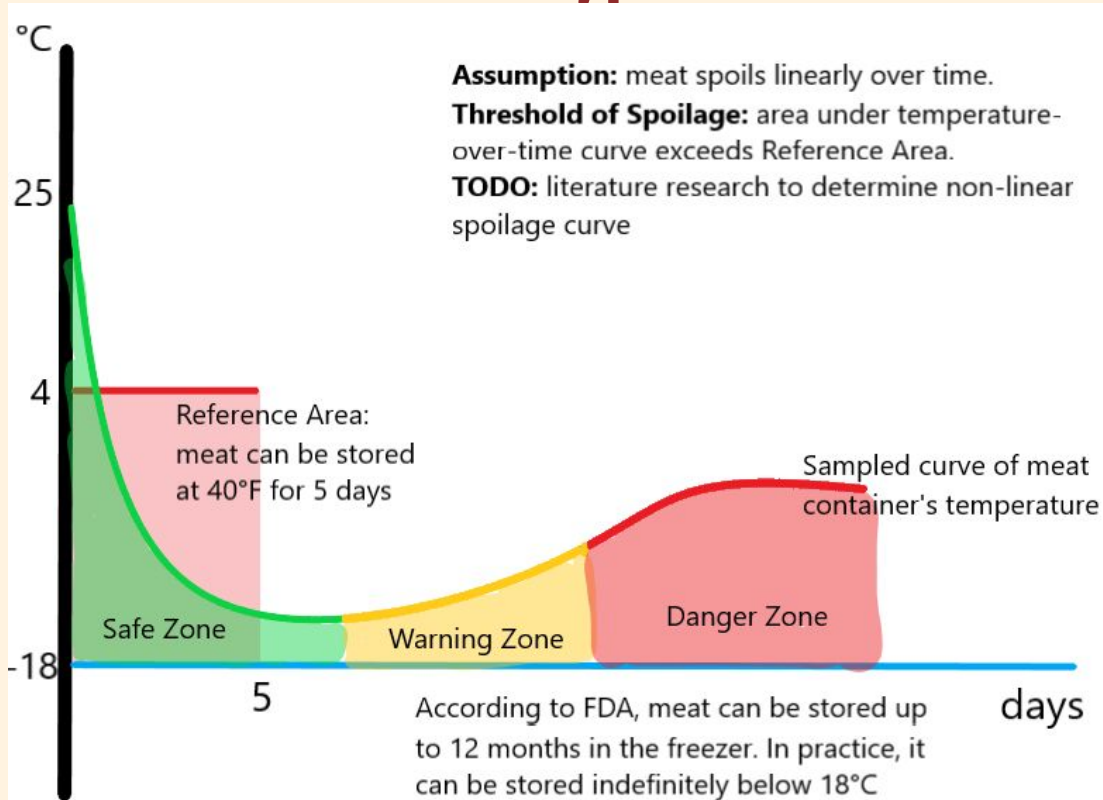


(prototype) 3 LEDs
Green: safe
Yellow: warning (area > max/2)
Red: spoiled (area > max)

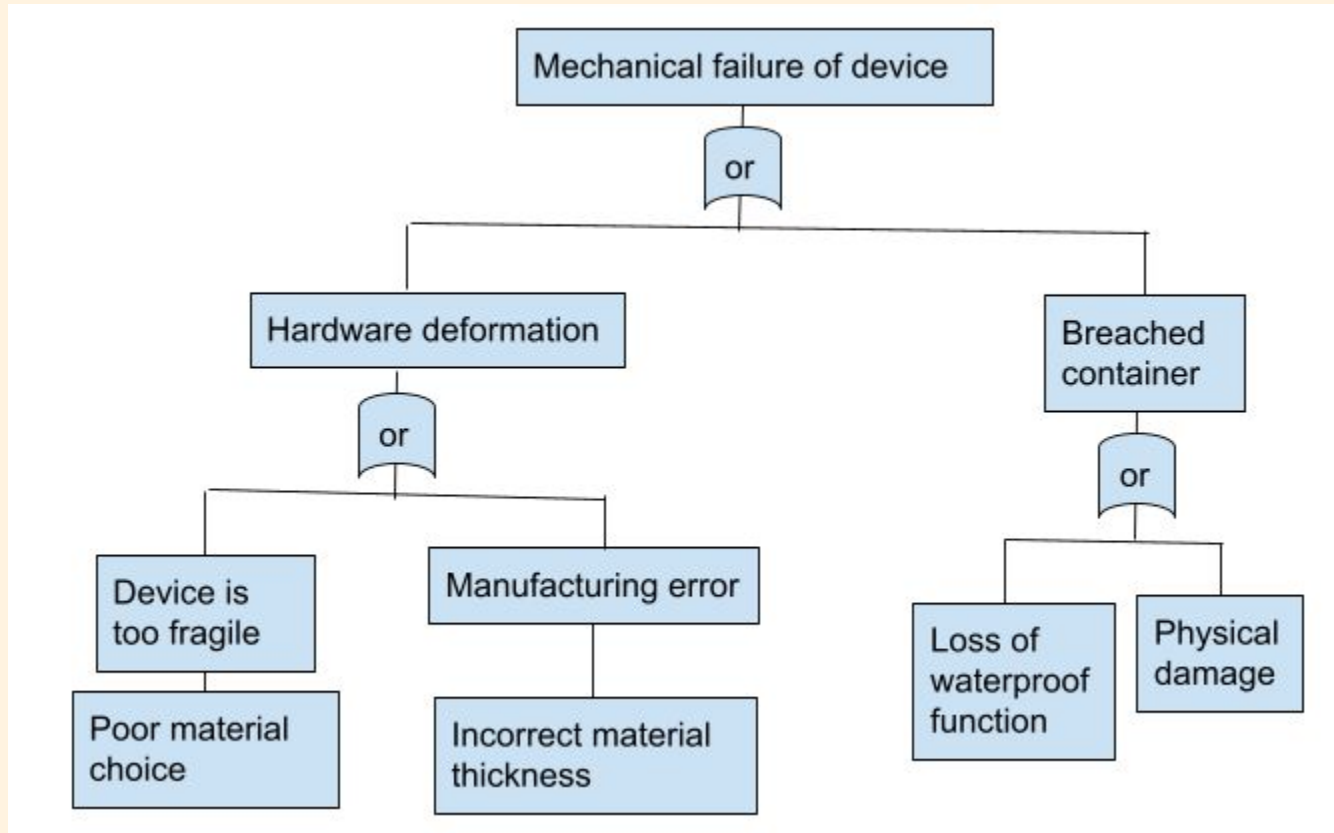


(prototype) LCD screen display current temperature and area under the curve (/1000) over threshold area (/1000)

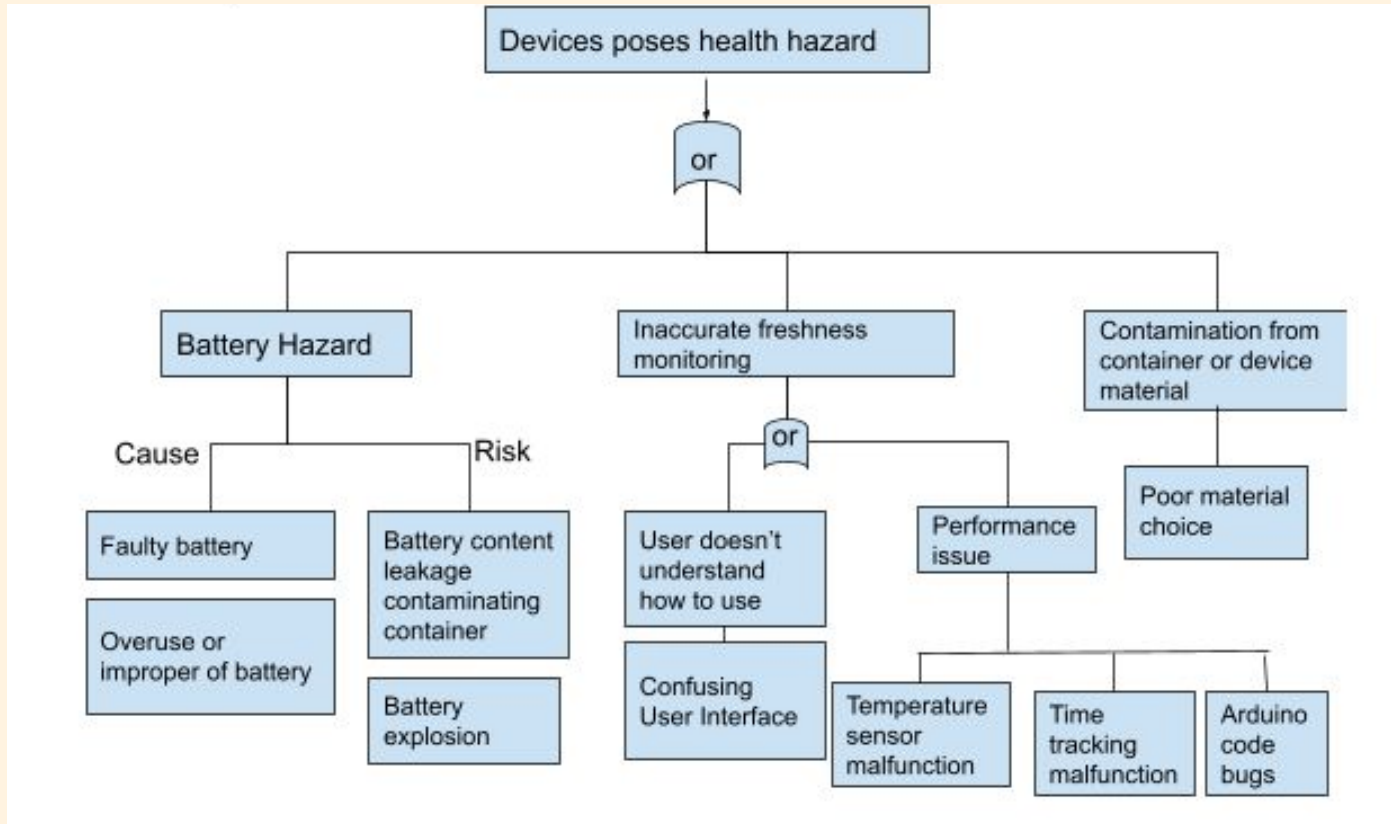
Prototype



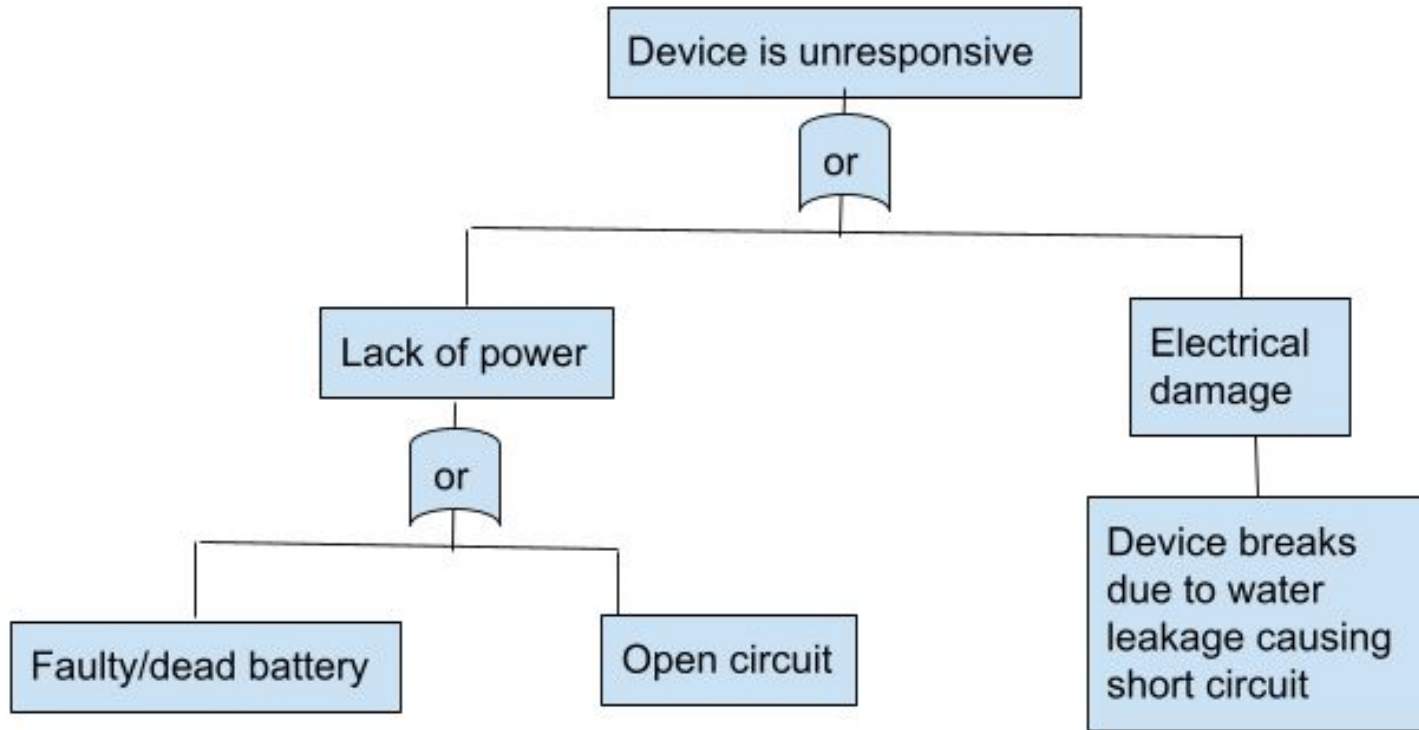
Fault Tree Analysis 1



Fault Tree Analysis 2



Fault Tree Analysis 3



Risk Analysis

- Made directly from Fault Tree Analysis
- No resulting “red” scores using risk mitigation

Severity Rating		Examples
5	Major Harm	Illness
4	Minor Harm	Shock, burn
3	Major Inconvenience	Device doesn't work at all
2	Minor Inconvenience	Some aspects of device don't work
1	Negligible	Doesn't disrupt function
Occurrence Rating	Definition	Estimated Failure Rate
5	Frequent	Every few days
4	Probable	Every few weeks
3	Occasional	Every few months
2	Remote	Once a year
1	Improbable	Once every three years

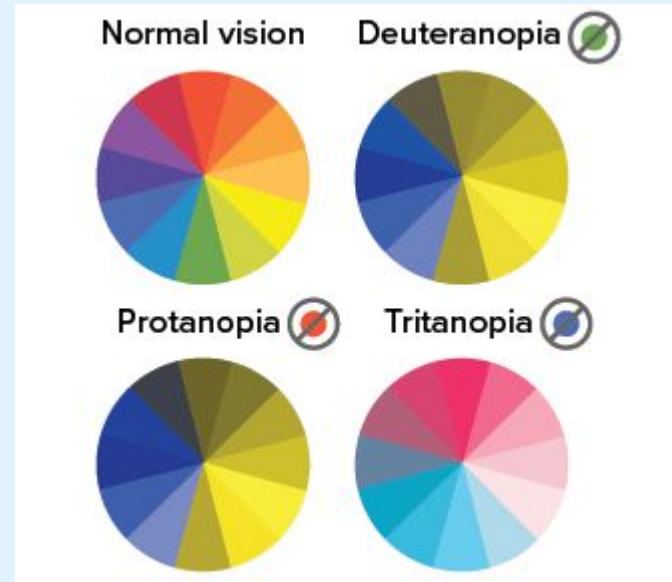
Next Steps

- Prototype Construction
- Design Verification
 - Acceptance Criteria Testing
 - Input/Output Verification
- Revise Prototype
- Design Validation
- Continued user research/feedback!



Challenges

- Visual user display
 - Device accessibility
- Making device easy to wash
 - Electrical components



Other

Challenges:

- Finding time to meet and complete assignments
- Assignment distribution

Teamwork:

- Working together on zoom
- Meeting once or twice each week



Questions?

Thank you!