Know It's Off

# Project Closeout

Project Members:
Aaron Garcia —— garcaaro@oregonstate.edu
Douglas Wilson —— wilsondo@oregonstate.edu
Kiernan Canavan —— canavank@oregonstate.edu
Tyler Titsworth —— titswort@oregonstate.edu
Project Partner:
Donald Heer —— heer@eecs.oregonstate.edu

May 20, 2021

# Contents

# 1 Design Impact Statement

According to the National Fire Protection Association in the United States on average 172,000 home structure fires were caused by cooking between the years of 2014 to 2018 [1]. In that statistic, unattended cooking was noted as being the leading cause or cooking related fires and casualties [1]. The Know It's Off system will allow users to check their oven status remotely. From there they can then take the actions necessary to remedy the situation if they found out it was left on. While our device does not have the capability itself to stop fires we hope to enable users with knowledge they can use to be proactive in preventing house fires. However, a false "OFF" reading could cause an operational oven to be left unattended which could result in a house fire and by extension structural or bodily harm. On the other hand, a false "ON" reading will pose less actual risk but could be quite irritating and confusing to the user.

The popularity of smart homes is on the rise throughout every segment of the population. Many individuals are increasingly security and privacy-conscious and as such many don't wish to install systems that they feel will spy on them [2]. The Know It's Off system collects very little data in comparison to other smart devices and will only allow Google Assistant access with the user's express permission. Users that find this device convenient maybe encouraged to continue making their homes "smarter" with the addition of more devices, making smart homes more common in general and therefore more culturally acceptable, privacy concerns notwithstanding.

Electronic waste or e-waste is garbage which is made up of discarded or broken electronic devices. In the United States alone we generated 6918 Kilotons of e-Waste in 2019 [3]. This translates to roughly 21kg per person per year of E-waste [3]. Since our device is made out of inexpensive ABS plastic and consumer grade components it is reasonable to assume that it will not last for a decade or more and will eventually need to be disposed of. Our Know it's Off project also consists of two separate modules which require their own separate circuit board and enclosure thereby generating more potential e-waste. By choosing to use a rechargeable battery over a disposable battery pack we are hopefully offsetting some of the potential e-waste generated by the device. Instead of needing to buy and dispose of single use batteries the user can instead utilize the included charging module to recharge the Know It's Off device without needing to dispose of non-recyclable materials.

With smart appliance integration on the rise, Technavio Research projects that from 2020-2024 there will be an increase in growth of 31.66 billion dollars in the smart appliance market [4]. Despite widespread adoption of these newer technologies, home appliances often last for decades [5]. While smart appliances are not significantly more expensive than their counterparts, most find it unnecessary to upgrade a functional oven, stove or fridge solely for smart home integration. Know It's Off provides a cheap alternative to smart appliances for individuals that do not need an appliance upgrade, but still want the basic functionality and safety features of the newer models. The Know It's Off system will also be able to work with any device that has a status indicator light,

while also using much cheaper parts. This would save customers money and the added flexibility of deployment can encourage them to use it on a wider range of appliances.

## 2 Project Timeline

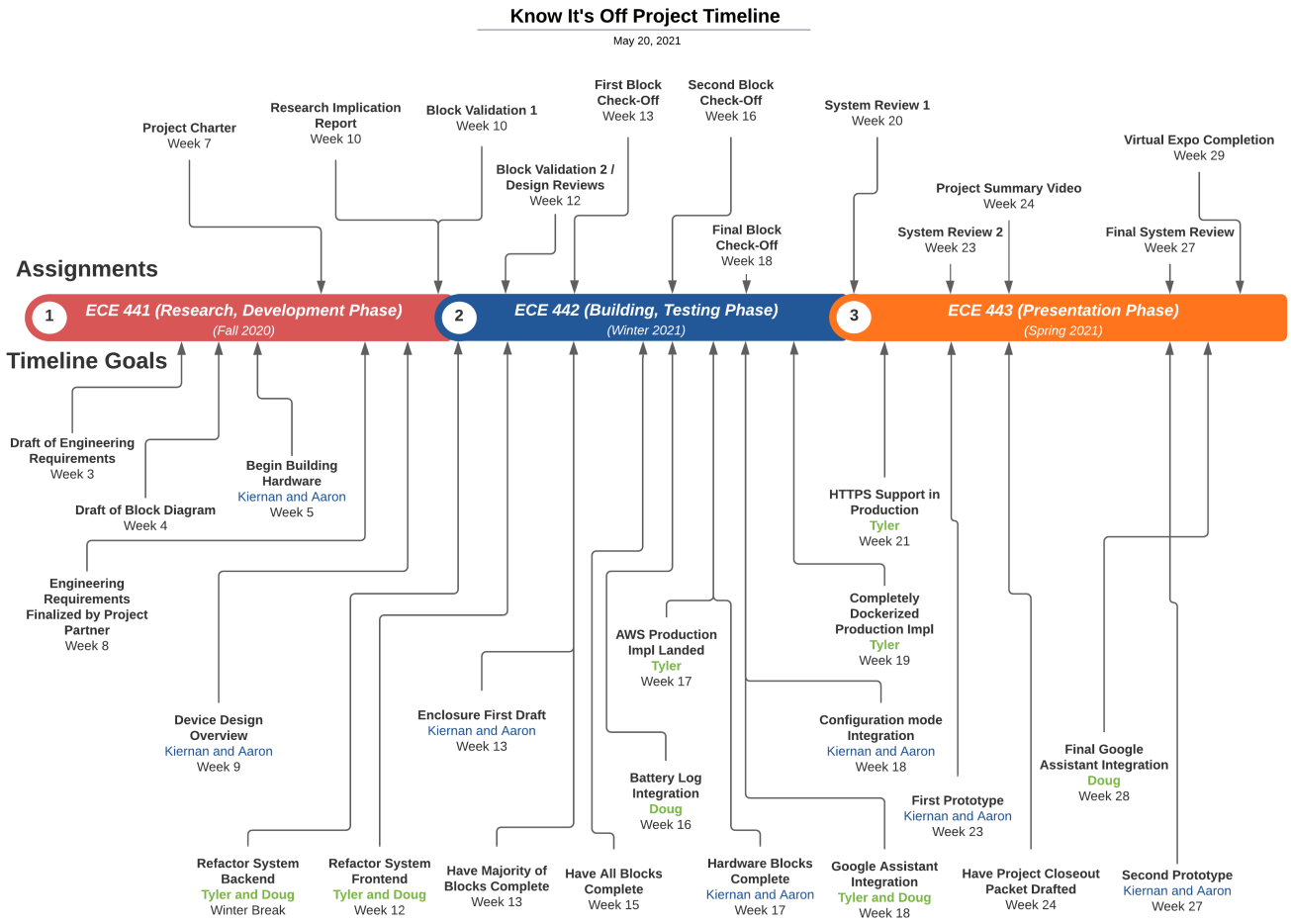


Figure 1: Internal Timeline

# 3 Scope and Engineering Requirements Summary

| Name | CR | ER | Verification Method | Test Process | Test Pass Condition | Evidence Link |
|---|---|---|---|---|---|---|
| Detection Latency | The device will detect the current status of an oven on light. | The system will reflect the proper state of the oven in the user interface within 60 seconds of the state changing. | Test | 1. Verify that the testing oven is off. 2. Attach the system to the oven face in its intended position and orientation as specified in the user documentation. 3. Power on the system as specified in the user documentation. 4. Allow the system 60 seconds of start up. 5. Simultaneously start a 60 second timer and turn on the oven. 6. Verify that the state has been toggled to on" in the user interface before the timer reaches 60 seconds by refreshing the current page." | The system passes if it reflects the proper state of the oven in the user interface within 60 seconds of the state changing. | N/A |
| Device Identification | The user should be able to identify a device and its state. | 9 out of 10 users can identify the device and the state of the device from the system output. | Test | 1. Access the online interface. 2. Look at the device and its state. Have 10 people try this process. | If 9 out of 10 users can identify the device and the state of the device this test passes. | Hyperlink |
| Device Power | The device should operate for as long as possible without replacing the battery or recharging. | The system will be rechargeable and last at least three months without having to be recharged | Analysis | 1. Fully Charge Lithium-Ion battery 2. Run Device for 5 days under normal use (Normal Use: Each day while the device is running turn on oven or oven light substitute for 30 minutes and then turn it back off. Repeat this 3 times per day to mimic an oven being used for breakfast, lunch, and dinner.) 3. Disconnect battery and discharge across resistor of known resistance 4. Using Arduino Uno monitor the time it takes for battery to reach discharge cutoff 5. Using time and discharge current calculate the charge that was left in the battery after 5 days of use. (Assume 3 months is roughly 91 days and thus 5 days would correlate to 5.5% of total charge) | Test is passed if the leftover charge was 94.5% of full capacity or 378mAh. | N/A |

| | | | | | | |
|---|---|---|---|---|---|---|
| Device Security | Only a 'Know It's Off' device can connect to the 'Know It's Off' interface | The system only acknowledges registered device IDs sending valid status signals | Demonstration | 1. Register a device with a valid device ID. 2. Attempt to register a device with an invalid device ID 3. With a registered device ID, turn on the oven light, and send the proper status signal to the database to validate the device registration | The system disallows invalid device IDs | Hyperlink |
| Device Size | The Device should be as small as possible. | The system must be smaller than 20.0mm x 40.0mm, with a maximum thickness of 15.0mm. | Test | 1. Locate calipers with a precision of 0.1mm or greater. 2. Identify the top of the device by placing the OSU logo facing upwards 3. Measure the length and width of the system at its largest point. 4. Measure the thickness of the system at its largest point. | If the system is smaller than 20.0mm x 40.0mm x 15mm, then the system passes. | Hyperlink |
| Google Home Integration | A Google Account can ask their google assistant device is my [insert name here] on and it will respond with a yes or no | The system must allow 9/10 Accounts to use Google Assistant to find the current state of their appliance. | Test | 1. Account prompts Google Assistant on their smart phone device. 2. The account will say or type in Talk to Know Its Off". 3. Google Assistant will ask the account what appliance they want to check. 4. The account will state the appliance. 5. Google Assistant will state the state of the appliance." | The test passes if the user is able to access the interface through an external network and the state successfully changes within 1 minute. | N/A |
| Interface Accessibility | The Device Application can be accessed from their phone from outside their home. | The user can access the system interface over an external network and see changes within 1 minute. | Test | 1. Using a cell phone, deactivate wifi connection and use cellular data and connect to the web application. 2. Change the state of the device and verify that its status changes on the web application within 1 minute by refreshing the page. | The test passes if the user is able to access the interface through an external network and the state successfully changes within 1 minute. | N/A |
| Status Light Visibility | The status light needs to be visible when the system is mounted. | The system must allow 9/10 people to correctly discern the state of a test led from a distance of 1 meter that has a luminous flux of 0.5 lumens. | Demonstration | 1. Verify operation of a 0.5 lumen led mounted underneath a flat, transparent surface. 2. Attach the system onto the flat, transparent surface above the led. 3. Verify that 9/10 people can correctly discern the state of the led from a distance of 1 meter. | The system passes if 9/10 people can correctly discern the state of the test led of 0.5 lumens from a distance of 1 meter. | N/A |

# 4 Risk Register

| RiskID | Description | Category | Probability | Impact | Performance Indicator | Responsible Party | Action Plan |
|---|---|---|---|---|---|---|---|
| R0 | An error in PCB design results in a defective board. | Technical | 35% | H | A mismatched PCB pad/hole or incorrect circuit design. | ECE Team | Reduce |
| R1 | The cloud based server hosting the database goes down. | External | 40% | L | The user will not be able to see their devices and their states. | Douglas Wilson | Retain |
| R2 | The cloud service hosting the database suffers a data breach. | External, Legal | 5% | L | Newspapers report a data breach in the team's cloud service. | Douglas Wilson | Transfer |
| R3 | Traveling delays prevent the team from meeting. | Timeline | 10% | L | A discord message that states that the team member will be late. | All Members | Retain |
| R4 | Users can not navigate the web application easily. | Technical | 25% | H | Users will complain through surveys. | CS Team | Reduce |
| R5 | A team member gets sick with Covid-19. | Project Schedule | 10% | H | A team member becomes ill and can't work to their full abilities. | All Members | Reduce |

**Risks Summary**

Over the course of the project, the team did suffer from risks R0, R1 and R4, of which R0 hit the hardest. In the course of the assembly and testing of our final circuit board we did find some errors and as such design revisions were made and parts and circuit boards needed to be ordered. Issues like this cropping up well into the middle weeks of the term brought about a lot of stress due to the time needed to wait for manufacturing, shipping, assembly, and finally testing. Our action plan to reduce this likelihood could have been better executed if circuit designs were double checked by multiple team members. Some of the delays were outside our sphere of influence as an unexpected snowstorm in Texas greatly delayed the shipment of a few critical components to our device.

The CS team did run into issues with R5, where users had some issues navigating the Know It's Off website interface. Users had a difficult time navigating the edit user page, but had little difficulty navigating the rest of the site. This issue was foreseen and additional development time was taken to fix the problem. An issue that surprised the CS team was intergrating Google Assistant into the backend of our webservice. The microservice had great difficulty in recognising user's voices and outputting the correct data, and

there was little the CS team could do to fix it. The problem fixed itself weeks later when the CS team attempted to intergrate again weeks later.

# 5 Future Recommendations

| Num. | Type | Recommendation | Reason | Starting Point |
|---|---|---|---|---|
| 1 | Hardware | Improve Battery Lifetime | Allow user longer operating times without needing to recharge the battery. In doing so we can reduce the chance of a stale reading due to discharged module. | Seek out efficiency specialised voltage regulation ICs and low leakage transistors.Tune resistance values in light sensing circuit to trigger correctly without drawing any excess current. |
| 2 | Hardware | Make the sensing module's enclosure water resistant | Protect device from splashes or spills. | Test enclosure for water ingress points. Redesign enclosure to be able to fit a rubber gasket if necessary. |
| 3 | Best Practice | Order doubles of components and place orders well before deadline to test. | With small surface mount components it is remarkably easy to lose them and thus is imperative to have backup components. Unexpected shipping delays can disrupt the project timeline but this affect can be mitigated by placing orders early | Communicate with team about budget and purchasing standards. |
| 4 | Hardware | Solder ESP8266 IC directly to device PCB. | Currently we are using an ESP8266 transceiver module with included through hole pads, power LED, and antenna. This increases the width and height of the sensing module and is unnecessary. | Redesign PCB to work with new ESP8266 footprint. Research methods of making an antenna with PCB traces. |
| 5 | Software | Refactor Authentication to use Google OAuth v2 | Better integration with GCP | See the Flask OAuth Library |
| 6 | Software | Create a System Unit Test | It increases the relative security of the web application and allows for richer code | See how to Unit Test in React and move to Flask afterwards. |
| 7 | Software | Create a Mobile App based on Web Application | Increases relative usability | See about converting a React app to Android/iOS |
| 8 | Software | Train the Google Assistant to have greater accuracy | Currently our Google Assistant has a lower training accuracy than expected, this makes it difficult for users to verify their device state while using google assistant | Train the system more and create a better webhook design that involves a string parsing algorithm like fuzzy matching. |

**Note to Future Engineers**

The Know It's Off team would like to congratulate the next team members assigned to this project and ask them to view the following links containing materials to help them on their journey:

- https://github.com/titswort/know-its-off
- https://drive.google.com/drive/folders/168pbWIIE01XvCgvPQocodXuJtvq9ZIGi?usp=sharing

# References


[1] N. F. P. Association. (2020) Home cooking fires report. [Online]. Available: https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem/Home-Cooking-Fires#:~:text=US%20fire%20departments%20responded%20to,direct%20property%20damage%20per%20year

[2] A. Arnold. (2018) More millennials are becoming homeowners, but do they want smart homes? [Online]. Available: https://www.forbes.com/sites/andrewarnold/2018/05/28/more-millennials-are-becoming-homeowners-but-do-they-want-smart-homes/?sh=61725dab38f8

[3] T. G. E.-W. S. Partnership. (2021) United states of america. [Online]. Available: https://globalewaste.org/statistics/country/united-states-of-america/2019/

[4] B. Wire. (2020) Smart home appliances market 2020-2024 — growing adoption of wireless connecting devices and iot to boost growth — technavio. [Online]. Available: https://www.businesswire.com/news/home/20200313005321/en/Smart-Home-Appliances-Market-2020-2024-Growing-Adoption-of-Wireless

[5] A. H. Inspection. (2013) Average lifespan of home appliances, and mechanicals. [Online]. Available: https://www.atdhomeinspection.com/advice/average-product-life/