

Energy Saving Emily

A smart digital figurine that monitors energy consumption, and encourages more efficient use through negative reinforcement.

[Prototype Video Link](#)

Problem Space

Energy consumption in Australia is continuing to rise with Australians being one of the highest per-capita greenhouse polluters in the world and households being responsible for the majority of this [1][2]. A study into energy efficiency in households found that only 26% of households say their home is energy efficient with a further 36% being unsure if they have a problem [3]. Every day people are becoming more and more aware of the impact that their energy consumption has on their energy bills and the environment. With this increased focus, people are trying to make conscious decisions to try to reduce their individual impact; but this isn't always easy.



Concept

Emily is a small digital figurine that responds to the environment around it and encourages a conscious effort in minimising energy consumption in the household. It does this by using playful, but annoying, tactics to alert the user when they are inefficiently doing so. These tactics involve colour change, vibrations, facial expression changes, complaining, and singing. Emily aims to create an emotional connection with the user to promote continued use, while also annoying them to encourage this behaviour change through discomfort.

Our team has all decided to create an energy monitoring device that creates change through negative reinforcement but have focused on different target groups. This means each form is adjusted to fit that group. The focus for my prototype is for families with school aged children to make better choices regarding energy consumption and also teach the children about saving energy.

Related Work

The film JEXI, explores the idea of creating an emotional connection with a technology, to mitigate the negative effects on long-term use. In the film, the main character gets a new phone that has a virtual assistant that has a personality and overrides his decisions to try to make his life better [4]. Of course in this film, it all goes wrong, but the main character does start to have an emotional connection with JEXI and feels bad if he disappoints her. This use of emotional connection to encourage continued use has been explored in the project.

Lua is a digital pot plant that monitors the needs of the plant and uses a screen with facial expressions to personify the plant, alerting the user of it's needs. This idea has been considered in the project, by Emily being a physical representation of the environment.

[1] Australian Government. 2019. *Australian Energy Update 2019*. Available at:

https://www.energy.gov.au/sites/default/files/australian_energy_statistics_2019_energy_update_report_september.pdf

[2] Energy Matters. n.d. *Energy Efficiency in Australia*. Available at: <https://www.energymatters.com.au/energy-efficiency/>

[3] Energy Consumers Australia. 2018. *Only 1 in 4 say their homes are energy efficient*. Available at:

<https://energyconsumersaustralia.com.au/news/only-1-in-4-say-their-homes-are-energy-efficient>

[4] Wikipedia. 2019. *Jexi*. Available at: <https://en.wikipedia.org/wiki/Jexi>

[5] Mu-Design. 2019. *Lua*. Available at: <https://mu-design.lu/lu/#lua-intro>

Design Process

Overview

This iteration of the design process has focused on the discovery of many of my research questions surrounding the topic. In particular these included:

1. Create a prototype that effectively implements all intended features.
2. Create a form that is help create an emotional connection with Emily.
3. Research effective negative reinforcement techniques and what annoys people about technology.
4. Research effective ways to create an emotional connection with a device.

User Testing Findings

I conducted interviews with four people, with the focus on: what responses annoy people when using a device (e.g. their phone); how to find a balance between annoying the user too much and not enough (and if having an emotional connection helps this); and attributes in current devices or movie characters that makes you like them. These casual interviews revealed a lot of important considerations to be made when creating the prototype. Most users found loud and constant noises, vibrations, and difficult to use technologies (e.g. apps) most annoying. All users agreed that they would discontinue using a product if it was too annoying to use, however, one user revealed that if they purchased the product with the intention to promote a behaviour change, the annoyance would be a helpful reminder. They also suggested that if it was playful and fun to interact with it the annoyance could be fun too. When describing features that make you emotionally connected to a cartoon, all users described specific facial features (e.g. big eyes) and cute voices.

I conducted another set of interviews with five people that aimed to understand people's environmentally-conscious decisions. All participants stated that they had left their air conditioner on for much longer than they needed with 80% stating that this was the most important behaviour they wanted to change. One respondent explained that they often feel guilty about leaving the air conditioner on but leave it on anyway as no one is there to judge them. All participants agreed that their main method for saving electricity is turning off lights when they leave a room or the house. These interviews confirmed my initial assumption that the most important behaviour to focus on for this prototype is air conditioner and heater usage.

Interaction Elements

My initial plan was to use alarms as a method of negative reinforcement. However, after some feedback from the tutors, they suggested that this might be too annoying for the user and would discourage continued use. They suggested that a more passive aggressive tone to Emily would be more effective. This was also confirmed by the user testing described above. From this discovery, I decided to look into Text-To-Speech software to help add to Emily's personality as well as acting as a form of negative reinforcement. After looking into some text-to-speech tools, I found one called DecTalk [1] that allowed different tones to be played and found a module (emic2 text-to-speech synthesizer module) that could be connected to my esp-32 that would then play these sounds. I also found a library that had created lots of files of songs that used the dectalk algorithm. I decided to add speech from Emily to gain the users' attention if they haven't walked past her in a while by singing "Everybody Hurts". I thought this would also help add to her personality and provide more differing interactions with Emily so the process isn't so structured. As Emily would be used by a family, the method for turning Emily off should be simple for both children and adults and easy to integrate into their everyday lives. For this reason, the current method for turning Emily off is just simply touching both of her arms.

Technology

I started constructing my prototype using the Arduino, however through user testing and further

[1] Lanlost. 2016. [META] Download, Singing Instructions, etc. Available at: https://www.reddit.com/r/DecTalk/comments/3z97m2/meta_download_singing_instructions_etc/
DECO3850/7385 Prototype Lucy Davidson

Design Process

discovery into the interaction elements, I decided an esp-32 would be required for the prototype. This was because the screen and speakers would have difficulty running on the Arduino due to the limited space on the device for images and sounds. I started with the M5 Stack as I thought it might be easier to program and set up. However, once I got the screen working, I tried to move the other features across and this was very difficult due to its compact nature. I then decided it was best just to go with a plain esp-32. Although it was quite a bit more complicated than just the Arduino, these features were necessary for the project objectives.

Form Material

I spent a lot of time exploring different alternatives for the Emily's form. There were 3 main requirements for the form:

1. Transparent enough to let light through
2. Opaque enough to keep the wiring hidden
3. Solid enough to stand on its own

I started with Protoputty, as I could create a unique shape that would help promote an emotional connection with Emily. However, through extended experimentation with the material, I found it was too difficult to get it thin enough to let light through while also maintaining structural integrity to stand alone.

Finally, I decided on laser cutting the individual pieces using white acrylic. This method passed all the requirements and would allow more time to design the object rather than trying to just sculpt it in the 15 minutes Protoputty allows. I used boxes.py to create a basic hexagon template with finger joints to make the assembly process easier [1].

Form Design

In our team proposal video, we described Emily's form as a ball. However through discovery into creating an emotional connection, I decided that more personality needs to be portrayed in the form. I went back to my original concept for the "Project Ideas and Inspirations" presentation and decided that the cactus design is still fitting for Emily and would help with this personality requirement (figure 1). For the first print, I had a hexagonal box, but after printing it and putting it together, the cactus shape was lost a bit (figure 2). I had to make each piece quite wide to fit the screen in, however this made the shape a lot wider than I expected. I decided to remove some of the pieces and make it a rectangle shape so that it still could be identified as a cactus (figure 3). I also only printed the front in acrylic to save materials for the final product but still have the light up effect. For the next iteration, I need to figure out a way to create the bend in the arm using the laser cutter as at the moment it looks very stiff and un-cactus-like.



Figure 1.
Initial Design

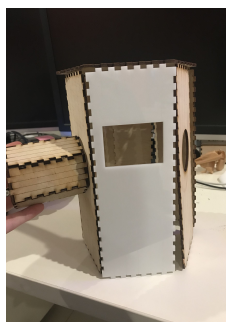


Figure 2.
First Print



Figure 3.
Final Design

[1] Boxes.py. n.d. *Regular Box*. Available at: <https://www.festi.info/boxes.py/RegularBox?language=en>

Interaction Plan

As my target user group is families with young children, Emily will be placed in a public area of the house (most likely the living room) to encourage spontaneous and continued interaction with Emily.

Use Scenario

The family installs Emily in their living room to allow the whole family to interact with it. The family as a whole want to make their household more energy efficient and the parents want to teach their children about their energy consumption behaviours.

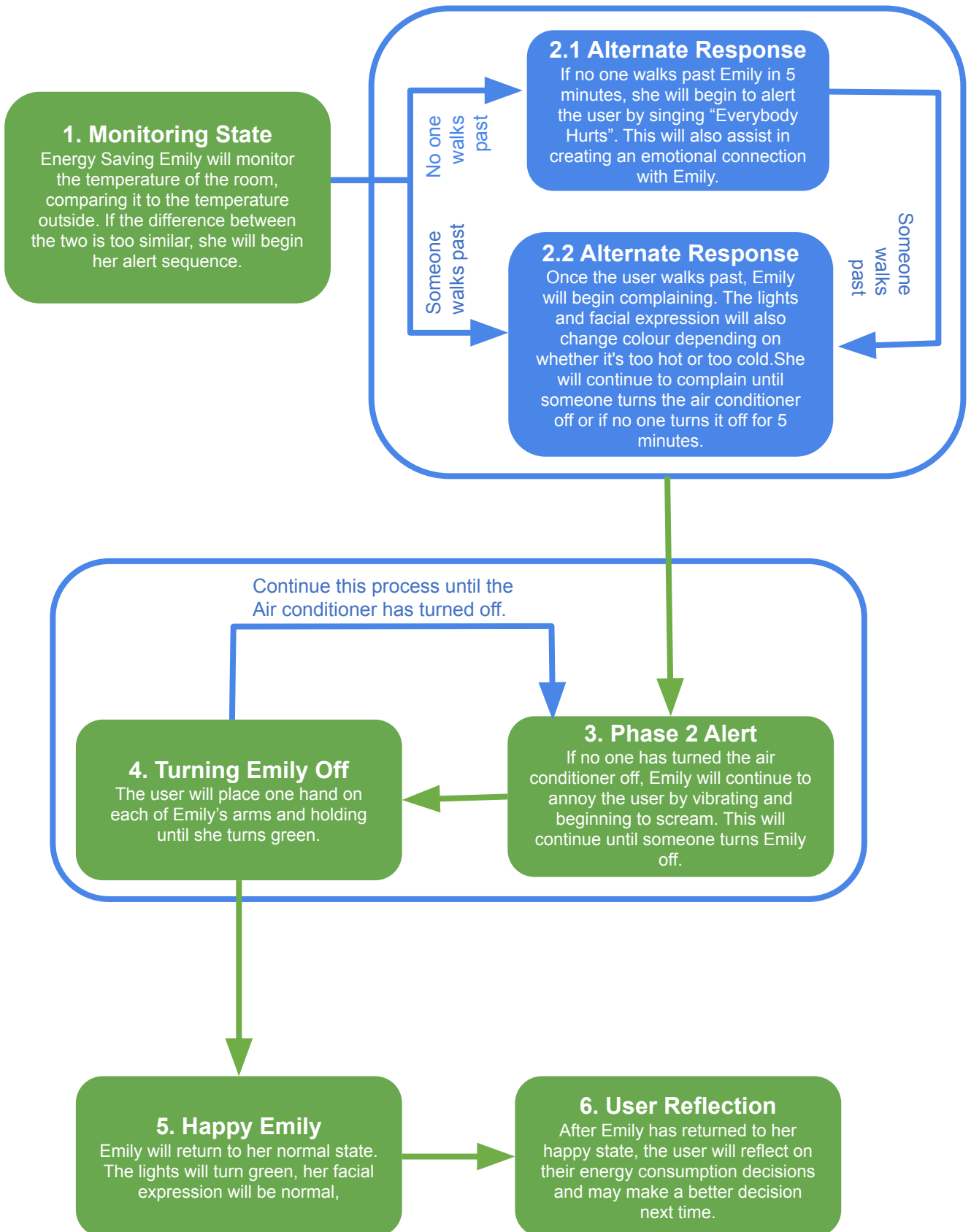
Intended Outcomes

Emily is intended to playfully annoy the user enough to encourage a behaviour change. The user is intended to create an emotional connection with Emily and want to work with her to decrease their energy consumption as a household. Emily will annoy the user more and more until they turn her off, but will continue to annoy the user until they turn off the source of the inefficient behaviour (i.e. the air conditioner or heater). Emily will provide constant feedback to the user so that they can immediately change their behaviour but will also influence their long term decision-making behaviour and attitude toward energy consumption.

Interaction Plan

The following page outlines the intended interaction with Emily.

Interaction Plan



Project Objectives and Success Criteria

The table below outlines the project objectives with their respective success criteria and measure of success items, as well as when and how often to test these criteria.

Project Objectives	Success Criteria	Measure of Success (When to test)
1. As a user I want to be reminded when my energy consumption behaviour is inefficient so that I can save money and the environment.	<ol style="list-style-type: none"> Emily constantly monitors the indoor and outdoor temperature. Emily compares the two temperatures and alerts the user when they are being inefficient. Emily uses useful tactics such as lights, vibrations, and sounds to alert the user. 	<ol style="list-style-type: none"> Was the indoor temperature and weather API data being recorded? (each new iteration) Does the alert sequence begin when these datasets are compared and deemed inefficient? (each new iteration) Do the facial expressions, lights, vibrations and sounds work correctly at the correct time? (each new iteration) Do users in user testing deem these tactics useful? (early in development phase)
2. As a parent I want to be able to use Emily to teach my children about their energy consumption behaviours.	<ol style="list-style-type: none"> Emily records and compares the indoor and outdoor temperature. Emily can be easily turned off by all age groups. Emily's outputs (lights, vibrations, sounds) are easily understood by the user. Emily is durable enough to be used by children. 	<ol style="list-style-type: none"> Was the indoor temperature and weather API recorded and compared? (each new iteration) Can all users from varying age groups turn Emily off? (user testing after prototype deliverable) Do any users in user testing have difficulty understanding the state that Emily is in? (user testing after prototype deliverable) Does Emily have a durable form that doesn't break or disconnect during testing? (user testing near end of build)
3. As a user I want to be able to incorporate using Emily with my everyday life.	<ol style="list-style-type: none"> Emily can be turned off using the touch sensors on the arms. Emily has varying levels of negative reinforcement that only progress if the user doesn't change their behaviour. Emily can easily be placed and interacted with in a public part of the house. 	<ol style="list-style-type: none"> Does Emily turn off and only turn off when both arms are touched? (each new iteration) Does Emily only proceed to the next level of negative reinforcement if the behaviour doesn't change? (near end of build) Can Emily be easily moved? (after build)
4. As a user, I want to be able to change my long term decision making around making environmentally conscious decisions.	<ol style="list-style-type: none"> Emily is only annoying when the behaviour is inefficient. Emily has some positive reinforcement behaviours as well. 	<ol style="list-style-type: none"> Does Emily only begin the alert protocol when the indoor temperature is deemed inefficient? (each new iteration) Does Emily thank the user when they make the right decision? (near end of build)
5. As a user, I want to be annoyed by Emily so that I change my behaviour but still continue to use her everyday.	<ol style="list-style-type: none"> Emily has an appropriate level of annoyance. 	<ol style="list-style-type: none"> Do any users find Emily too annoying to discontinue using her everyday? (user testing after prototype deliverable)