ELECO: REDUCING ENERGY CONSUMPTION ONE WINDOW AT A TIME

INTRODUCTION

When addressing environmentally sustainable behaviour within households, energy consumption immediately provoked my curiosity, as our day-to-day lives would not be permitted to run as effortlessly as now, without a dependable and consistent energy supply. [1] In pursuit of uncovering potential shortcomings within modern households, a piecework was encountered by AECOM, reporting on the on-going challenge concerning the development of smart buildings accommodating low energy consumption and adequate individual well-being. The author encapsulates the attention of the audience on operable windows as a source for reducing the electricity consumption within a building. Two predominant approaches are discussed; an (1) automated approach and a (2) manual approach.

1. The automated approach employs complementary devices known as actuators, to automatically execute actions without human interference, preventing human unpredictability and fault.
2. The manual approach employs an illuminating device to communicate to passer-by individuals of pressing actions to be carried out, offering a more simple and simplified solution with window control.

- ❑ Both approaches accomplish their respective purpose with the assistance of environmental sensors, mounted indoors and outdoors.

Conclusively at the end, the author recommends for an approach that encompasses the cooperation of the approaches, eradicating in this manner the complexities featured. [2] Bearing this in mind, the topic at hand was delved deeper by studying devices that provision individuals with surveyal of egress points of a household, especially windows.

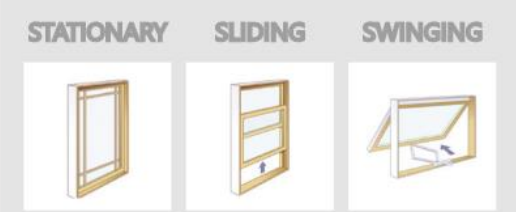
STATE OF THE ART REVIEW

Before anything else, research was promptly conducted on actuator devices available in the market, and in particular window openers. Starting off, these devices make available to an individual a broad arsenal of interactive tools:

- ✓ Mobile app permitting an individual to oversee/configure the device
- ✓ Connectivity with smart home devices (e.g., Alexa)
- ✓ Offer excellent configuration competence with complementary technology (e.g., rain sensor) [4]

With this in mind, window openers were observed to pose a sequence of potential complexities. First things first, the installation of such a system entails a level of effort, as well as constraints emerging from the fact that --

-- windows comprise of distinct structures, dimensions and operation modes.[6] Amongst many, three leading types of windows were classified, namely (1) Stationary windows, (2) Swinging windows, and (3) Sliding windows. [3]



Not to mention, installation usually involves securing the device onto the subsurface of a window with screws, bringing about some degree of undesirable damage. [4] On another note, the capital and maintenance expenditures are relatively beyond the budget of the average household, considering the employment of numerous such devices.

Another analogous system, that can be associated with the manual approach discussed, is a burglar alarm system. Typically, a sequence of sensors is employed within an environment, for the purpose of detecting the motion of an object and carrying out a set of pre-defined counteractions, namely the sounding of an alarm, activation of lights, transmission of warning notifications, and so on. A common approach employs infrared sensors, which make usage of infrared light to compute a change in the space between the sensor and an object. [7] In the case of windows, such a system can recognize when a window has been opened or closed.

IDEATION On the whole, I have come into agreement with tackling the energy consumption topic, with an approach that shares elements from automated and manual tactics. Nonetheless, from the investigation conducted, I concluded that available relevant products are not only scarce, but also struggle in provisioning a singular standalone solution that incentives individual in the formation of a cooperative relationship. Following some brainstorming, the idea of employing smart --

-- planters, comparable technological devices that position houseplants at the spotlight, ensuring the survival and well-being of the houseplant. I was immediately intrigued by this green approach, straying away from the complications surroundings windows whilst offering appropriate incentivization for engagement with the device. Even so, there is a strong correlation between plants and windows, permitting the potential of "killing" two birds with one stone; (1) regulating the egress points around the house, and (2) ensuring the survival of plants. Below are some relevant facts:

- ✓ Benefit from windows preventing harmful UV rays [9]
- ✓ Houseplants improve indoor aesthetics (e.g., warm, comfort) [11]
- ✓ Photosynthesis can release electrons which can be harvested for electricity, acting as a power source. [8,12]
- ✓ Houseplants improve human well-being (e.g., stress, mood,) [10]
- ✓ Houseplants eradicate pollutants, essentially filtering and cleaning the atmosphere. [10,11]

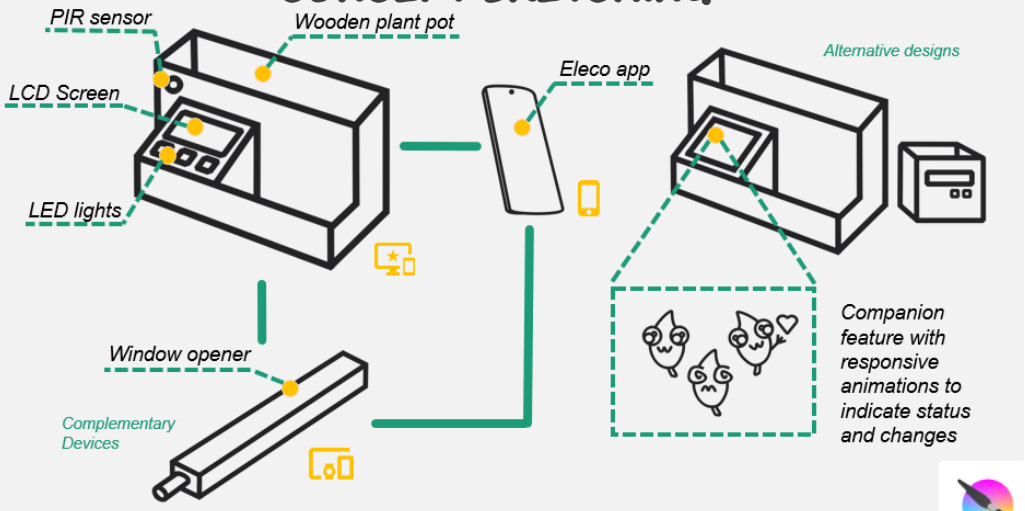
And thus, **ELECO** was created (*deriving from the abbreviated words "electricity" and "eco"*), a standalone self-sufficient device that employs a series of sensors to accumulate and exhibit environmental data (e.g., humidity, temperature), in order to make informative decisions (e.g., closing the window). Focus is placed on ensuring the houseplant is thriving, as it acts as the power source for the device. To reduce the carbon footprint a step beyond, authentic timber was chosen as the material for the planter, a sustainable option that offers long-term usability and renewability. [13] On top of that, existing timber planters can be employed to accomplish this.

SKETCHING

Fundamentally, the system embroils of a singular smart planter, or more, forming a network of devices that can communicate and share environmental data, to get the best precision. The synthesized concept, however, can further communicate with other smart supplementary devices, outspreading the system capabilities. Most importantly, the device offers communication with an individual through a display screen and indicator light.

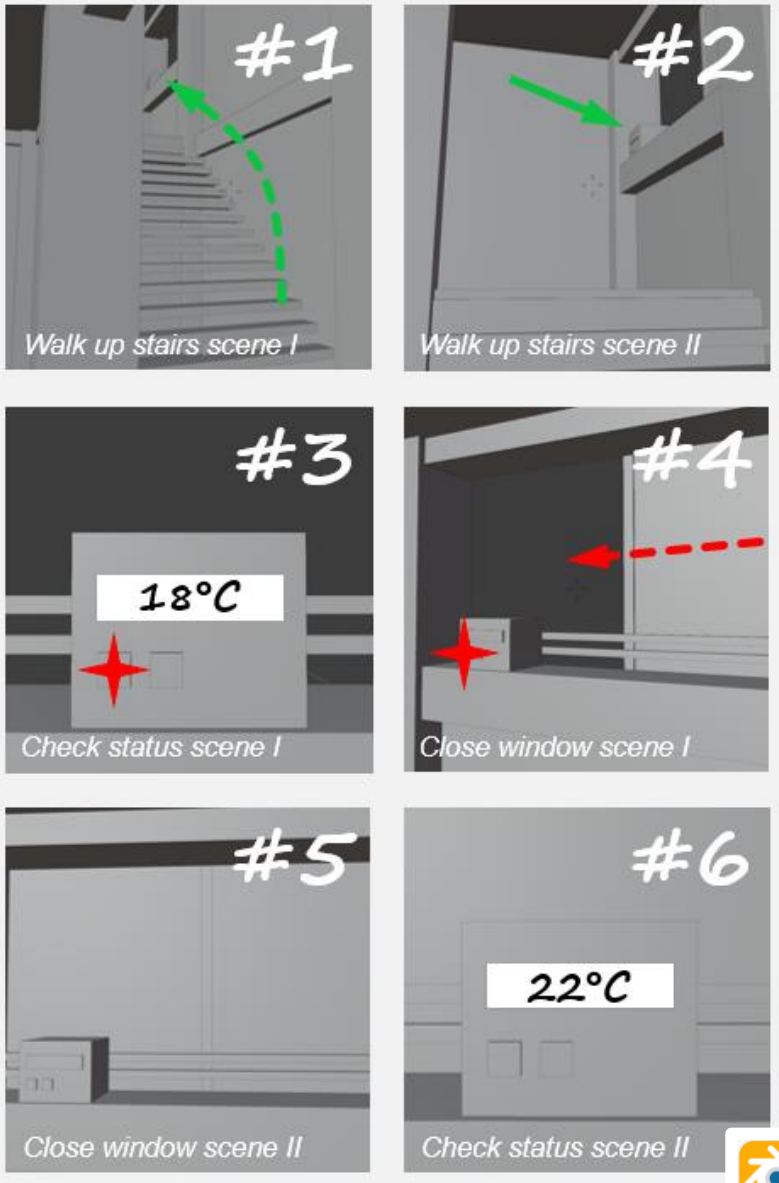
DESIGN IDEAS

CONCEPT SKETCHING



STORYBOARD (NOT END-CONCEPT DEVICE)

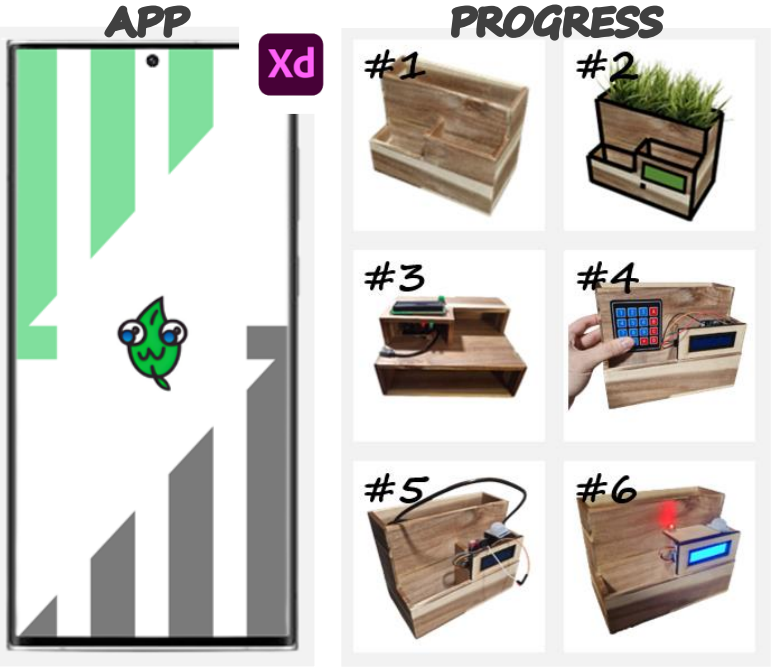
First person point of view



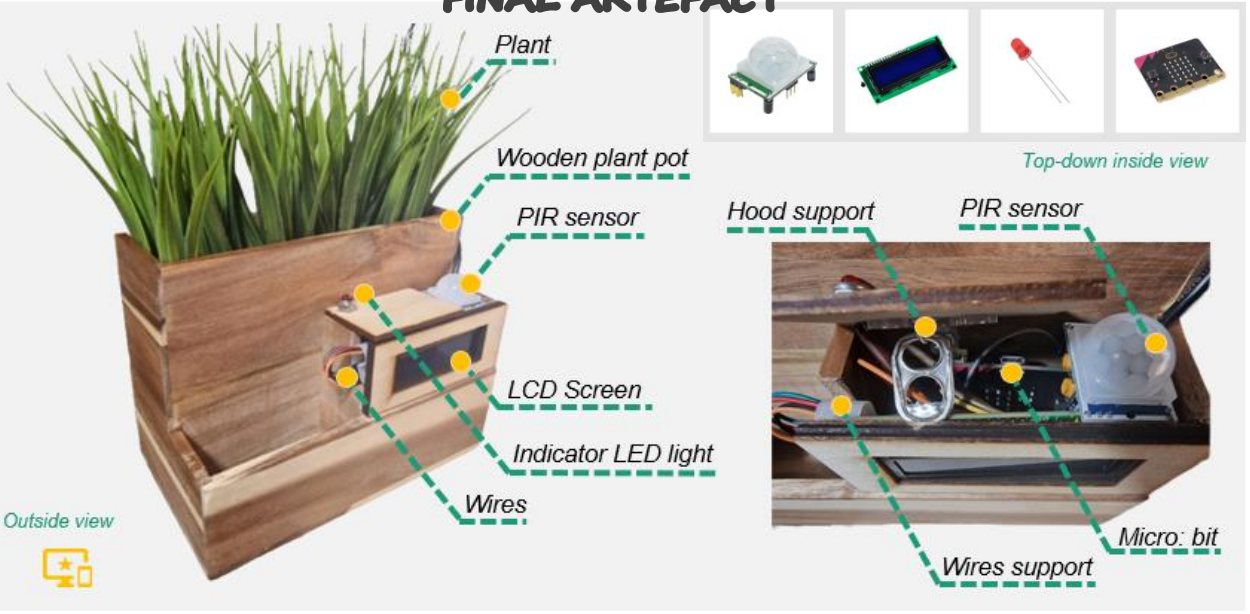
PROTOTYPING

The development journey of the physical artefact commenced by scavenging and securing an appropriate vessel to represent a planter made from timber or analogous material. The procurement of an actual planter rather than crafting one from scratch would support the vision of employing and transforming existing planters. Upon the acquirement of a planter, the model was experimented and processed to fathom how to translate the concept onto the accessible design. Whilst objectively simple, prerequisite proposed by the concept was ensuring a minimalistic visualisation of technology. Four components were utilized in the development of the artefact; the micro: bit (+ in-build temp sensor), an LCD screen, a PIR sensor and a LED light. Considerations were made regarding the implementation of interactive buttons, a scrapped idea replaced by the availability of buttons by the micro: bit. For this, a custom hood was produced to permit entry to the micro: bit.

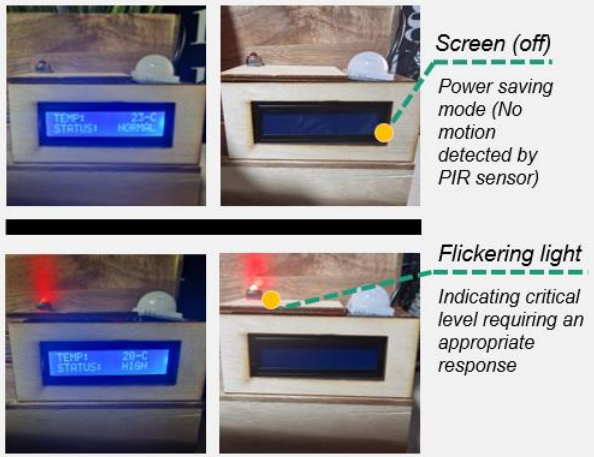
As showcased below, the artefact encompasses a PIR sensor, mounted for the purpose of reducing energy consumption by activating upon close-proximity contact with the device. Even so, since the energy consumption of the indicative LED is low, it remains permanently active to permit long-range visualisation of warnings.



FINAL ARTEFACT



OPERATION STATES



ELECO

DISCUSSION

The entirety of the process was carried out smoothly, without any complications or unpredictable events. The environmentally sustainable objectives set out, can be said to have been realised, provisioning a personalised approach on the matter at hand. The development of **ELECO** fulfilled the desired concept of a device that:

- ✓ Operates on green power
- ✓ Does not harm the environment
- ✓ Endeavours to reduce energy consumption
- ✓ Follows the concept of hygge

Unfortunately, however, there are some areas of interest that were still not embarked on. For starters, the micro: bit implementation did not record nor process the procured environmental data (e.g., temperature from in-build sensor). The back-end offered utterly restricted and incomplete possibilities to be envisioned. Another notable enhancement of the device, concerns the potential implementation of complementary LED lights that offer distinct suggestions, forewarnings and so on.

As part of future development, I seek to venture into putting into practice the concept of a plant powered device, as the current implementation operates primarily via cable linkage or alternatively batteries. Likewise pursuing to expand the glimpses presented by the concept, at the potential employment of planters of diverse dimensions, forms, and materiality.

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