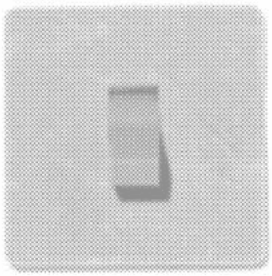
un-Compliant mechanisms

the report



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0. Index

1. Prologue

I want to start this report by acknowledging some important people in my life that have been of great value both to me and this project.

Zeynep Ugur

Omar J.W. Heuves

Gabriele Ferri

and finally my Mom.

As a designer, throughout my educational career my identity and vision have shifted many times. I have been lingering around, trying to find my spiritual path in design and I feel like I have reached a moment of stillness in this journey with un-Compliant mechanisms.

I value tangibility of objects and I treat everything that I can experience as having an aesthetic interaction. This experientiality of things has become my core value in design.

Before picking my squad, I consulted heavily on peers. I knew I wanted to explore tangibility in a different form but I didn't want to design a solution around it. Both Zeynep and Omar were involved in this choosing step, as well as Ian Zhang, who used to be a very influential member of Transforming Practices when I was doing my research project within the squad. I asked Zeynep how was it to work with Gabriele, and have only heard good things so I indeed decided to join the Transforming Practices squad. Reflecting back, I think I made the right choice based on the designer I evolved to become.

Ever since being a little child, I loved making things based on purely intuition. I formed emotional connections with how i would imagine the things I made and went through different journeys with them. This is how I want to design as well. By staying true to this root of mine embedded deep in my personality.

Being a "personal" designer in the sense that i do not have separate identities for who I am inside and outside of a design context is tough. Sometimes it makes me wait for that one bit of inspiration for days on end, but it also sometimes allows me to draw inspiration from every corner of my personal life and past knowledges, almost turning me into a ledger of designerly influences curated throughout my 24 year journey around the world so far. It keeps updating itself every day, forming new connections and relations to its existing entries.

Partially one of the key influences on the core aspect "actions have consequences" I attached to un-compliant mechanisms, comes from the fact that I failed my first attempt in my final bachelor project last year. It is a complex topic but to summarise, it happened because my headspace was prioritising other things in front of the project. Therefore I fully understand the outcome and perhaps from a karmic point of view, appreciate that it happened.

In reading this report, you will not be just interacting with my final bachelor project, you will be diving into who I have been as a person in this 6 month journey, how it has changed me and perhaps even see the weird little world I live inside my own mind.

2. Executive Summary

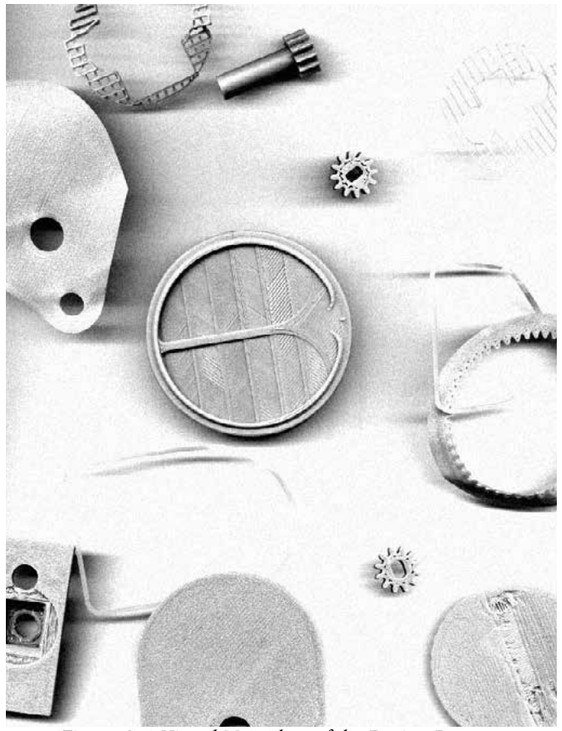


Figure 0: A Visual Metaphor of the Design Process

We live in an age, where all smart advancements in products serve to make life more convenient, give more control to the user, or to give us more and more choice.

But we live in an age, where there are more and more parties affected by the irresponsible decisions of humans. Un-compliant mechanisms want to create a point of contact between the human stakeholders and the non-human stakeholders of the physical realm around us, to give you a glimpse of what these products would like to communicate when you make certain decisions.

Un-compliant mechanisms are a set of products which will react to your interactions with them via haptics, sound and several sensory methods depending on whether or not your decisions will effect their future lifecycles as well. This shared “future” between the products and us revolves around the idea that all resources we have in this world are finite and we should act accordingly to this idea.

To demonstrate this, un-compliant mechanisms are designed as exaggerated products to be situated within a shared home with different human and non-human members. It is a thought study of discomfort with the premise to start exploring how we can incorporate meaningful smart home attributes as sub-components of appliances in our homes.

In this Journey, un-compliant mechanisms dives deep into the emotional connection humans and objects can form over interaction design and how these properties can create a new dynamic of human-object co-existence.

We will focus on design, philosophy within design, tangible making, haptics and connecting to other humans through non-living objects. We will go through the theoretical background, how it has been applied to the Journey of Un-compliant mechanisms, how they have been realized and validated through the hands of users.

This is also a demonstration of how me (Atacan Tutulmazay) and my experiences contribute to a way of designing I call “personal design”, drawing influences from my past experiences and lives.

The report is concluded with a conclusion and expectations for the future.

3. Introduction

Un-Compliant Mechanisms is an exploration on the politics of human-object relationship from an interaction design perspective.

Now, what do these buzzwords mean?

The creation of un-Compliant mechanisms, is intertwined with my personality as a designer and the challenges I keep seeing in the day-to-day interactions we have with the world around us. In its essence, it is an experience designed to re-establish the connection between humans and the fact that their actions have consequences.

Humans, beings, objects and designs are equal participants of the finite universe we all live in and therefore, should be allowed to contribute to each other by criticising wrongful actions.

Therefore, un-Compliant mechanisms are a set of exaggerated products which will react to your interactions with them via haptics, sound and several sensory methods depending on whether or not your decisions will affect their future lifecycles as well.

With these ideals, I designed un-compliant mechanisms in a very hands on manner, positioning it entirely upon creating an instrument which will provoke humans for moments of self reflection rather than giving them yet another point of access to the resources reserved for both humans and designs alike.

Un-compliant mechanisms are a set of products which will react to your interactions with them via haptics, sound and several sensory methods depending on whether or not your decisions will effect their future lifecycles as well. This shared “future” between the products and us revolves around the idea that all resources we have in this world are finite and we should act accordingly to this idea.

Because we see what happened when humans were allowed to rule the world by themselves.

4. Theories & Aproaches

Now that we have been introduced to un-compliant mechanisms, I want to discuss some of the concepts that has allowed me to realize this exploration effort.
As a passion driven designer, I work mainly based on obsessions and desires to explore. Below are some of my current obsessions in design which un-Compliant mechanisms are based upon:

Approach: Tangible Interaction

The first of these concepts is Tangible interaction. In a world of technology, where digitalisation is taking away feeling from everyday designs, I wanted to create tangibility.

One particular influence I had in this approach is Donald Norman's Emotional Design [1]:

"It is only at the reflective level that consciousness and the highest levels of feeling, emotions, and cognition reside. It is only here that the full impact of both thought and emotions are experienced. At the lower visceral and behavioral levels, there is only affect, but without interpretation or consciousness. Interpretation, understanding, and reasoning come from the reflective level." [1, pp 37-38]

I believe in creating questions instead of solutions. These questions aim to lead the recipient to find the solutions within their inner journey. Thus, I like creating tangible interactions to provoke people to reflect inside them to understand design, instead of being given an answer right away. In un-compliant mechanisms, I focused very heavily on this feeling aspect, as I wanted to create things that created the affordance of a relationship to be nurtured. This relationship is fuelled by the human recipient self reflecting consciously about the reactions they received from the explored products.

Approach: Perceiving the invisible

In a complex world, the inner workings of things are hidden and recipients are led to acceptance of concepts as a "magical service" instead of taking control. The TP Theories and Approaches document mentions this approach as:

"Perceiving the invisible aims to look at invisible processes structuring our everyday life, and questioning their impact on our behaviours, by making them visible." [2, pp 13-14]

My goal in design is to drive people into curiosity and exploration, the same way that design has changed the world I observe. In the scope of Un-compliant mechanisms, this idea was to unravel an otherwise lost dimension of connection between human actions and their consequences. This translated into giving un-compliant mechanisms human-like randomised behaviour curves and a point of communication that is to be self-interpreted as a reaction received after a request is made from an appliance. This action-reaction feedback loop in turn aims to make the human think what they just did, and how this affected both parties to lead up to this moment.

Theory: Flat Ontology

I was discussing what I envisioned to design in my final project with a friend of mine who is far more philosophically inclined than me, and she described my stance on objects human relation as resembling "flat ontology". From that point onwards, I put the core ethical values of my project to focus on all beings instead of the human. This led me to call this project a post-human interaction design project.

"Flat ontology is a model for reality that says that all object, even those that are imagined, have the same degree of being-ness as any other object. No object is more a subject than any other. All subjects are simply objects. The key factor in determining ontology is the ability of an object to affect another object. For example, if I imagine a rainbow and am therefore made happy, that rainbow is as real an object as my feelings of happiness, or me." [3]

In un-compliant mechanisms, I set out to break the hierarchy between stakeholders of finite resources around us, positioning objects and humans as peers who need to work together to nurture a relationship.

Flat ontology is not the thesis that all objects contribute equally, but that all objects equally exist. In its ontological egalitarianism, what flat ontology thus refuses is the erasure of any object as the mere construction of another object. [f]

This compound existence base therefore gives objects and humans the right to be opinionated on each others lives, as long as actions contribute to the future lifecycles of each other.

Theory: Post Phenomenology

Philosophy can shape how you explain things, and that is the "beauty of aesthetics" in my pinion. In the theory testing workshop in the squadspace I got acquainted with post phenomenology. Phenomenology meaning the "transmission of reality" does resonate well with un-compliant mechanisms as I wanted to utilise technology as a way of altering the perception and norms of tomorrow. I treat un-compliant mechanisms as a way of transmitting messages within the borders of human - tech - world. In figure 1 you may see how these were relevant in the theory tasting workshop.

This quote from the TP Theories and approaches document describes the relationship I wanted to form completely:

"The philosophy of post phenomenology gives you abstract handles to gain a deeper insight into how a design affects our everyday lives; how they shape what our world is and who we are?"

I didn't want un-compliant mechanisms to just be about aesthetics of interaction, instead I wanted to have a philosophical basis on who we are as humans and how our actions should have tangible consequences.

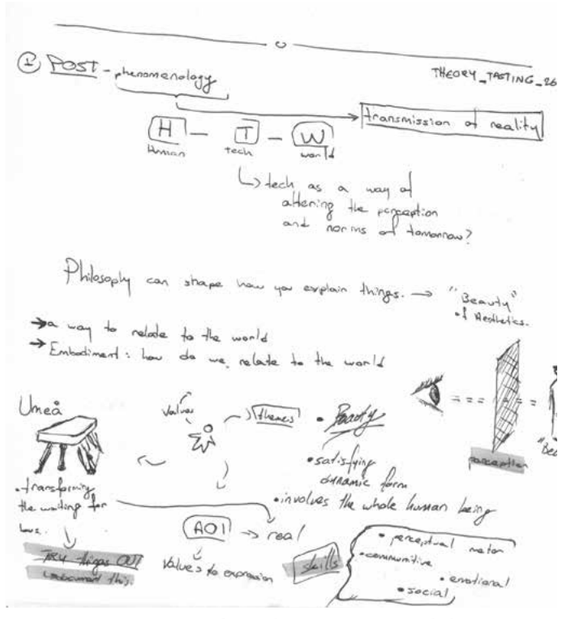


Figure 1: Notes from theory tasting workshop

A good analogy for these theories and approaches used in un-compliant mechanisms is as follows,

When camping, a person is more cautious about the water they consume because running out of water has a physical connotation of having to find a point to refill and comes with the hurdle of making the journey.

When at home, we are completely numb towards this connection, nothing has meaning anymore and everything is based on numbers and numbers alone. This is the shortcoming modern technology based societies has brought to us. Our actions have no consequences.

5. Design Process

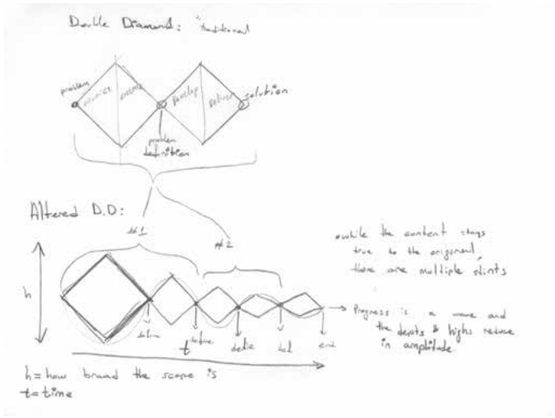


Figure 2: Altered Double Diamond Model

Now being acquainted with my mental journey with un-compliant mechanisms, I want to mention how the design process behind it looks like. For me, usually design processes are non-linear, as they might refer back to their original forms in late stages or might ditch aspects completely. But in this chapter I want to explain, how there is a method to this madness.

Being a passion driven designer, my personality is usually very involved in the projects I create. This is both a blessing and a curse, as I can accomplish a lot when I'm inspired but also my progress can freeze if that inspiration flies away or i am frustrated. I found methods to work this approach in a professional manner throughout my experiences in TU/e and in my personal projects.

I usually take a very critical approach to my own designs, in order to not fall into pitfalls that I have experienced in any previous projects. This involves learning on the fly and adapting to changes in my own design process sometimes mid project. From my previous projects, I already had a list of things I wanted to improve upon, and from the start I kept them in front of myself at all times. Being transparent is one of the main helping factors in this. In my first meeting with Gabriele, we mainly had a meeting not of design concepts but our anxieties in design. Luckily our anxieties were complimentary to each other's strong areas.

The personal shortcomings I noted down were as follows:

- Time management and buffering
- Timely Realization of prototypes
- Hyper-fixation on perfecting a design
- Validation of Design
- User testing

Throughout the project, having Gabriele aware of these areas I struggled in has been a blessing. I wanted to take initiative on learning to improve upon these areas and now reflecting back, I definitely feel like I have improved upon these areas. We will visit these in the following chapter, Journey as they come up.

I also took a more open approach to design this time. I was more observant on what the Transforming Practices Squad could teach me and how I could implement more to "change" the future one step at a time, incorporating a more peer review oriented approach.

Studying design has been about how to structure creativity to me for the most part. In this project, for my process I tried an altered double diamond [4] model that would suit my needs. While in a double diamond model the final step is a solution , I instead created a feedback loop for myself in the sense that there is no definitive solution. For the exploratory nature of un-compliant mechanisms, this made most sense. In figure 2, you may see how I sketched out my altered version of the double diamond.

This version adds a dimension called "h", which represents the broadness of exploration in each step, with the aim being as time progresses, the project becomes more and more specific and helps me avoid going into tangents, facilitating "making". The elongated shapes of diamonds, while not narrowing down on the time spent in each phase means that the details involved in each stint become finer, aiding development of my ideas.

It was difficult to follow this model at times, as I usually always find the next thing I hyper-fixate upon more attractive. I had to force myself to make definitive decisions on refusing exploration to deepen my understanding on certain topics quite a bit in this design process. One extreme precaution I took at every step of my project was to have a clear timeline ahead of mine to make sure that every exploration, every decision and every tangent was happening within a manageable timeframe. This was one of my biggest improvements compared to previous work I did.

Even though there is the mention of an altered double diamond here, in the actual journey I tend to blur the lines of where the diamonds start narrowing. To make sure that I stop exploring and start defining, I from time to time created arbitrary soft-deadlines for myself. In the following chapter, you may see this pattern emerging as we walk through the journey which eventually led up to un-compliant mechanisms.

6. Journey

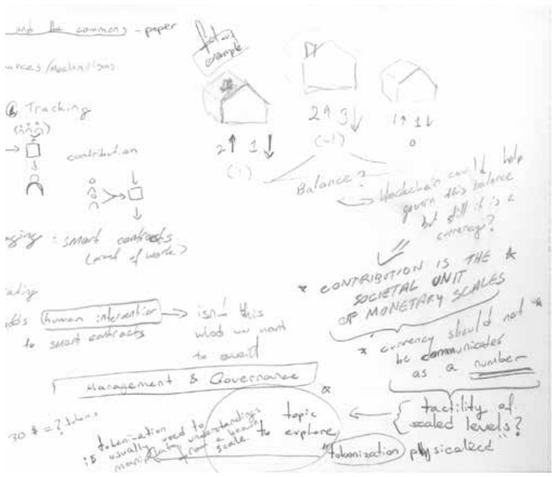


Figure 3: Blockchain and the Commons Notes

In the previous chapter, I went through some of the core values, approaches and ideals I had through the design. These ideals were discovered through experimentation, exploration and exchanges with valuable peers. In this chapter we will walk through the journey that led me to Un-Compliant Mechanisms.

Being an intuition powered designer who struggles to structure creativity, this time I decided to stay more structured, at least in the "archiving progress" part. Therefore from the beginning, I decided to take frequent meetings and notes to log where I am situated in this project.

Having decided upon a strategy to formulate my creativity with the Altered Double Diamond model has also allowed me to stay semi-structured throughout my journey. Most of these notes and explorations usually follow a non-linear path and therefore quite tough to follow along. This chapter will be organized around different tangents I hyper-fixated upon and where they led me.

Tangibility of Human-Object relationships and Commoning

Even before the project period began, I knew I wanted to make tangible things that served the function of testing human-object interactions, where a relationship was to be nurtured between human and non-human participants. I believed in objects having a way of communicating. Therefore, in the start one of the earliest meetings I had with Gabriele Ferri was about the topic and how we can make this happen within the concept of TP.

What I enjoyed from this first exploration was, the feeling that I had room to explore my obsessions in design freely while imagining a new future.

I dove into the first diamond in my altered model via the Ethnography workshop that happened as the first week of squad activities, the idea of commons was very prominent. I was intrigued about how inter-human interactions could turn into a commoning effort.

I read through "Blockchain and the Commons" [5], to take inspiration on exploring the commons, only to draw semi-related conclusions about the balance of human-human interactions. In a sense, within all of the tracking and contributing to society as a chore, I noted that "contribution is the societal unit of monetary scales", and that currencies should not be communicated as a number, leading me up to the tactility of tokenisation.

This explorative tangent therefore helped me realize how as human interactions become more and more complex, a simple monetary/number based scale to value things is not valid anymore.

As an example, in a remote self sufficient community, a plumbing service could be as crucial as a medical operation as the need for the respective expertise areas could be classified as being equally scarce. In figure 3, you may find some notes I took from the aforementioned research paper "the Blockchain and the Commons"

The first "iteration" I came up with in this direction concerned a common "monolith" to be situated in a co-energy dependent neighbourhood which would demonstrate human-like reactions to the way the community acted upon. This monolith would demonstrate a relationship to be nurtured by the human participants and it would be the common point of all stakeholders, almost like co-parenting a non living being. In figure 4 you may see how a public/private interaction scheme would be implemented as the action-reaction coupling of this idea.

With this knowledge, I reflected upon the current direction i was headed towards and made some decisions on which are to shift my scope towards. These reflections were more about asking the question why am I making this and how does this relate to my vision. From the beginning, my focus has always been around creating a different realm of tangible relationship between humans and objects. If I were to dive into exploring such a project within a neighbourhood context, the sheer amount of human-human interaction dynamics and societal norms would flood the headspace of the recipient of my designs, therefore taking me away from the ideal of questioning human-object relationships. With this consideration I decided to remove the neighbourhood

aspect to focus on a intra-household target group to simplify the exploration of tangible interactions. Our households inherently require interaction and care to operate and staying in this context would aid me to create experienceable, tangible things.

This definition also allowed me to start investigating in a new direction in the form of another diamond, which is now grounded on the first exploration. Before proceeding, I wrote down 3 main motivations for the next exploration I will be diving into:

- empathy by personifying the non-living

- designs as entities

- taking a more literal approach on common space.

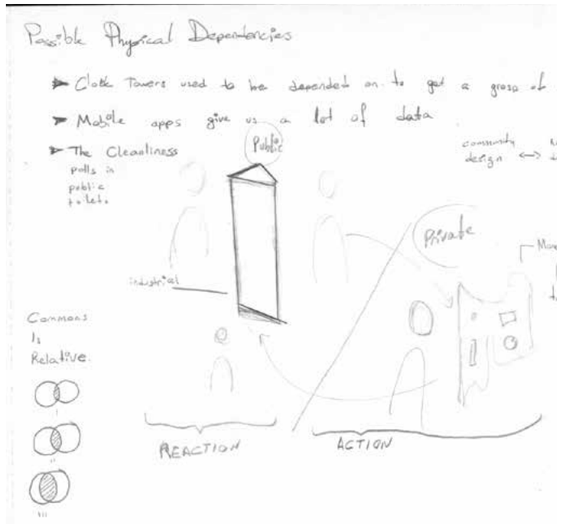


Figure 4: Public/Private interaction monolith

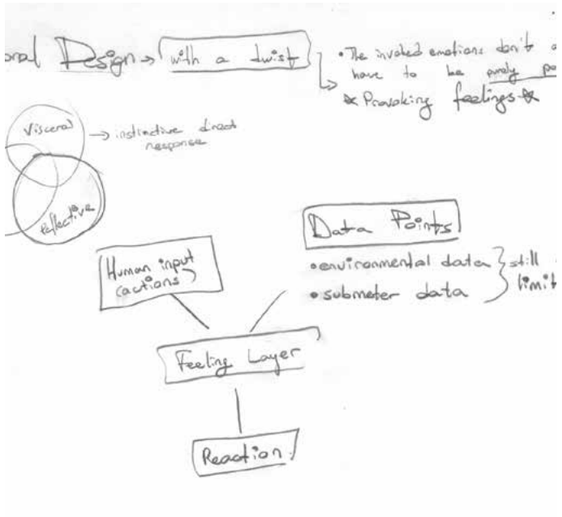


Figure 5: feeling layer ideation

Reactive Products - We get away with our Bullsh*t too much.

By shifting my focus to things that happen within households, I brainstormed with my core values, theories and approaches and re-defined my scope.

New Scope:

- Shared Houses
- Common Spaces inside dwellings
- Giving a Character entity to the commons
- Adding self awareness on consumption of Finite Resources
- Operation is data driven, Outcome is NOT data driven.

This new data-oriented approach was created by exploring how digitalised objects have lost their emotional connection to human interaction. Smart home products enable us to monitor every piece of information the specified outlets control, but numbers don't mean much to us because most of us don't have a inherent understanding of what "1 kW" means. Therefore I wanted to design for emotions and not for numbers. Connecting a "smart" solution to resource consumption habits created an inner dilemma revolving what I was actually trying to achieve. I strongly believe that the answer to a problem created by technology isn't more technology.

At this point, I looked up into Don Norman's Emotional Design. [1] In emotional Design, Norman mentions three different aspects of design. Visceral, behavioural and reflective [1, p.5]. I was more intrigued by behavioural and reflective designs as I wanted to provoke people by their interactions with a design. Behavioural design is more related to the pleasure and effectiveness of use and reflective design is related to the rationalisation and intellectualisation of a product.

From this reading, I formulated my approach as creating a "feeling layer" between the human input and the reaction generated by the product. The ideation sketch can be seen in figure 5. I wanted to combine data points and human inputs and feed them into a "feeling layer" to generate an appropriate reaction. What this reaction would be wasn't decided upon yet in this stage.

This reaction aspect, "functional friction" as I called it will therefore be implemented into the interactions i wanted to design, to create contrast to today's everyday solution oriented product designs, which are made to be smooth, removing any moment to think and reflect in the process. In Counterfunctional things: exploring possibilities in designing digital limitations [6], Pierce and Paulos mention a design called "table-non-table":

"The table- non-table was particularly open to simple actions that people may not have been fully aware of when the intersection occurred."

This table which doesn't follow normal table dimensions introduced some other ways to think and interact with an otherwise inanimate object just because of the un-common appearance. I took away that the unexpectedness of how a design behaves could be a worthy investigation. Besides this, adopting counter-functional characteristics on household input devices creates an emotional connection.

Counterfunctional things also influenced me in coming up with the naming scheme for the project, where it became un-compliant mechanisms. It got invented naturally as a word play on the common phrase "compliant mechanisms" in engineering. Compliant mechanisms besides this technical background, also made me think about the lack of feedback humans receive while acting with objects that have the sole purpose of serving them. By attaching the un- in the beginning, even though one might argue that it is actually grammatically wrong, the project got its character.

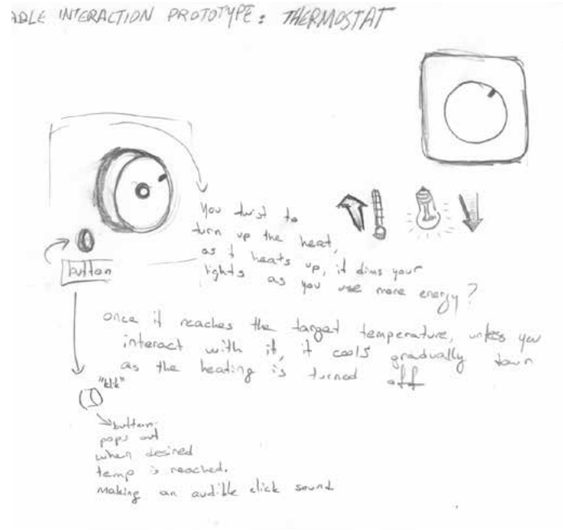


Figure 6: An uncomfortable thermostat

With this new branding and the previous decisions in designing around the context of an household, I brainstormed to come up with the idea of an "uncomfortable thermostat" seen in figure 6. This thermostat would apply force when the user would try to rotate it over a threshold value, forcing the user to think about why they are facing this reaction. On the midterm demo day I received a feedback asking "who would be the deciding factor in these thresholds", and I decided that is not an area I wanted to investigate. I position myself as not a creator of solutions but an exploration into the process of human-object interaction for the future.

After the midterm demo day (figure 7), Gabriele made a recommendation about checking some examples in Anthony Dunne and Fiona Raby's Design Noir [6], which has become a significant influence in the further journey of my designs.

Design Noir

Design Noir - the Secret Life of Electronic Objects is a book by Anthony Dunne and Fiona Raby[6]. It thinks of electronic objects being described as "smart" is a bland way to interpret them. In the first chapter they state

"thinking of them in terms of dreaminess rather than smartness opens them to more interesting interpretations" [7, p. 8].

Having mentioned a "feeling layer" in figure 5 that I wanted to introduce, i wanted to treat the designed reactions of the exploratory products i was making in a way that doesn't feel digitalised, but rather feels more human in their behaviour.

I usually state in daily discussions that I enjoy designing to provoke. Dunne and Raby state

"these objects would not help … it would force a decision onto the user."[7, p46]

In exploring which areas within a house these existential moments could be used to create moments of reflection, I looked into the common utilities that are consumed in day to day operations. Gas Water and Electricity are finite resources we all dwell on a daily basis, but our current connection to them in terms of a scale is attached to a monetary model, based on price. We usually see the effects of this either before in estimating [8] how much it will cost or afterwards when the bill comes. My aim is to form a tangible connection as this "consumption" happens to create. Therefore I narrowed my scope even further towards demonstrating how products may react in our relation to finite resources that both us and designs from an exploratory interaction sense.

Obsessive Making

Making things that actually work is a challenge, as you have to obsess over a lot of details. I didn't want un-compliant mechanisms to feel like a development toy. I wanted them to be complete, with their software, look, feel and behaviour.

I was confident in the direction of the project after the midterm demo day. I took another leap onto the following diamond, making the decision to lock my concept in and investigated how within the concept of un-compliant mechanisms I could build the best demonstrations of a different form of human-object interaction based on tangible haptics. I created an Anchor document which I will attach

un-compliant mechanisms:

commons as an entity

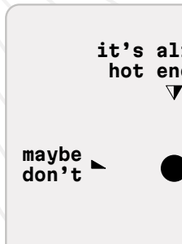
Scope: Commons within Shared Houses
Theory: Embodied Cognition

If we look at commons in a macro scale; humans and designs exist within the same finite materiality. What if we designed the home to contribute to this self awareness to show that our actions have consequences?

We get away with our bs too much.

product reactions

what if commodities weren't designed to be compliant for our own good?



Adopting counter-functional characteristics on household input devices creates an emotional connection.

My theory is that this emotional connection can aid self conscience.

reactive haptics?

example ecosystem to be user tested:

- Light Switch that shows resistance to being turned on during the day
- Shower head that cuts out intermittently to deter you from staying in too long
- Thermostat that doesn't like to stay on

How can "things" react?

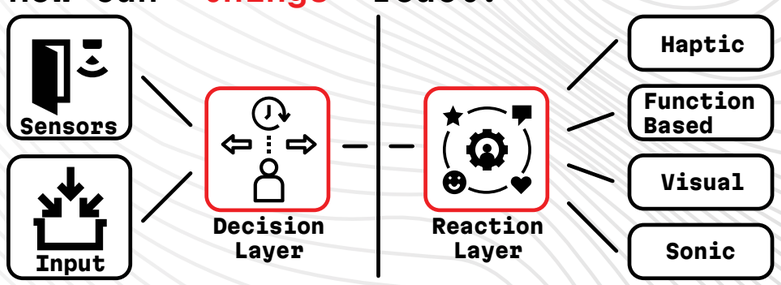


Figure 7: Midterm Demoday Poster

as an appendix to this report. This anchor document and the Scenario of how I imagined un-compliant mechanisms to function serves as a point of reference to fall back upon when I get lost in explorations. Also, another main value this anchor document hosts is the accountability of humans and their actions as desensitisation due to digitalisation.

To decide what to build and develop, I used one of the earliest tools we learned in TP, ethnography. In the household I live in, we live with 3 people who are in different stages of their lives. We are 2 students and one fresh graduate who just started working. In the previous section I mentioned finite resources such as electricity, gas and water. I therefore made notes following through our habits of consumption at home to learn about our "violations" regarding these resources.

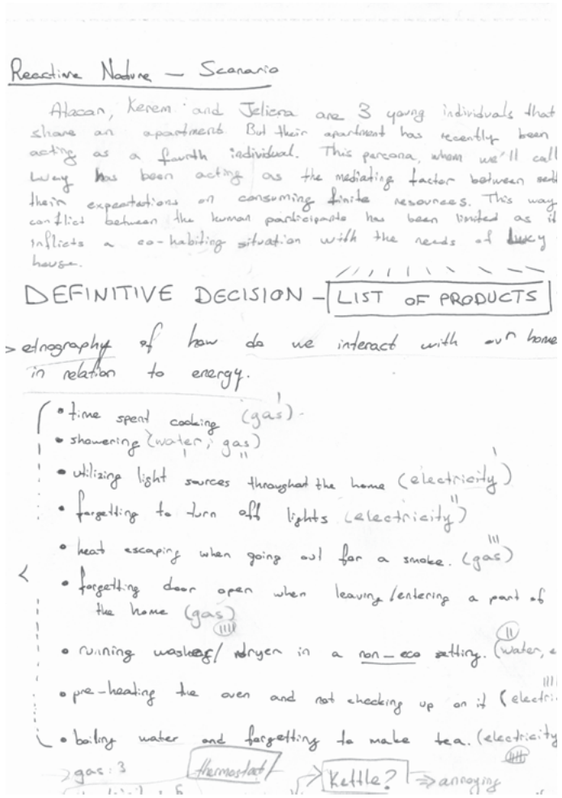


Figure 8: Violations and Ethnography

In figure 8, you may see the different moments of interaction w. excess resources I pinpointed within these ethnographic notes, while counting regarding which "service" these violations were related to. After counting these areas, I saw that electricity was the area we were most guilty of, with a total of 5 violations, versus 3 gas related violations and 2 water related violations.

This sub-section of the report is called obsessive making for a reason. With having desires of making tangible things that would connect humans to how their actions have consequences, I looked into several wall mounted appliances which usually serve as people's interfaces in households to gas/water/electricity. From this stage, with keeping mind the violations from my ethnographic notes, I came to a consensus of 5 prototypes:

1. Kettle
2. Shower head
3. Light Switch
4. Power Outlet
5. Thermostat.

Then, knowing that within the timeframe I had at hand, and the reality that I would also have to validate the functionality and behavioural properties of these products in a user testing protocol, I decided to go forward with three of the 5 prototypes. I decided to not follow through with the kettle and shower head for a variety of reasons. First, a light switch, power outlet and a thermostat all could be situated in the same wall, therefore the interaction setup I wanted to create would immerse the user more. Second, in user testing having a kettle or shower head would be very difficult. Heating water in a kettle takes a long time and there isn't much to do to speed it up, and the shower head would be very impractical in a experience corner setup.

With these "DEFINITIVE DECISIONS" made, as I call them in figure 8, I got into an obsessive making loop, with committing perhaps one of my best investments to my industrial design life so far. Purchasing my own 3D printer. In Figure 9, you may find "Egco", my 3D printer named after my high school friend who recommended this specific model to me.

I love rapid prototyping and I have enough affinity in CAD modelling that sometimes I don't even have to sketch an idea as it feels more practical to just draw it in cad. The convenience of having the 3D printer on my desk has allowed me to push on through with one of the shortcomings I mentioned before. I have been obsessing over a design too much, to an extent that it made realization of projects very delayed. Now with this new rapid validation cycle; i can imagine something, print it, touch it, see what is wrong with the part and iterate on it within an hour of me having the idea at the first place.

This journey of influences from my past life, current life, literature and research has eventually produced un-compliant mechanisms. In its essence, my projects represent my personal journey to an extent and every time, I figure more about myself and how my design process works best. Reflecting upon how fast paced, intense and sometimes crazy everything has been, I genuinely feel and see how I developed as a person, next to my developments as a designer. In terms of time management and buffering, by drawing physical timelines in regular intervals, I made sure that I had enough of a buffer that everything at the end of the project fit exactly where and how they should be, ranging from delays in realization of prototypes to having small family emergencies to occasional sick leave days.

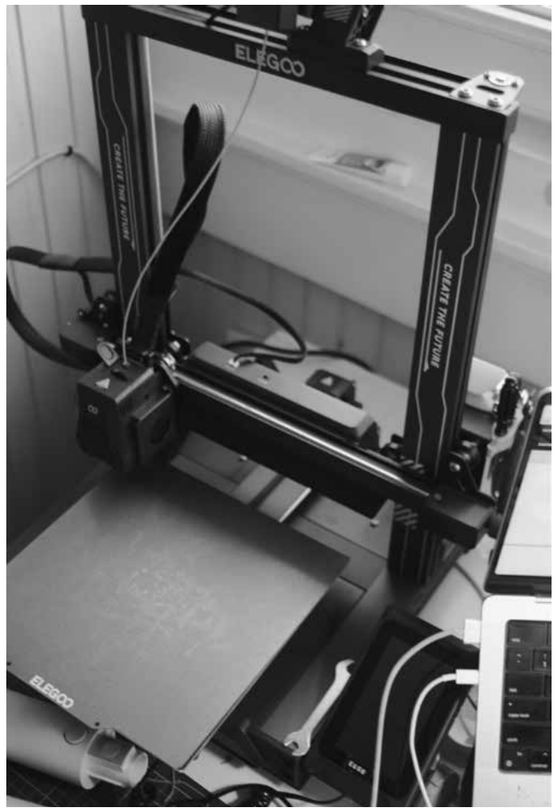


Figure 9: Egco, the 3D printer

7. Final Design

Figure 10: Prototype Personalities

> *"once electronic objects enter people's homes, they develop private lives" [7, p. 75]*

I wanted to start off with this quote from Design Noir, as it resonates exactly with how I imagine un-compliant mechanisms to live within a household. The final design of un-compliant mechanisms creates this thought that as humans, living beings, objects and designs alike; we share one common world together, making us all stakeholders in each others lifecycles.

Personalities

Having decided upon developing an ecosystem of wall mounted appliances that usually allow humans to access to utilities their house provides, I especially chose items that we don't really think twice while interacting. I wanted the products to be easy to forget about in their default compliantly designed nature. Power outlets, thermostats and light switches don't usually carry romanticised designs and meanings with them, usually being placed to fulfil a need and that need only. What you feel while you interact with them isn't as significant. Contrary to this, consumerism and partially design has brought humans to think about the decisions people make while buying mugs, clothes, cutlery sets and chairs. There is emotion involved in those choices, in a similar way how children become emotionally attached to their plushies and toys.

This imagination of what children go through while playing with an otherwise inanimate object has given me the idea to attach different personalities to each product within un-compliant mechanisms. As I wanted the interaction design to be revolving around emotions, I thought this would be a nice added layer on the behavioural properties of un-compliant mechanisms.

In Turkish Aviation, there is a legendary airplane nicknamed "Deli Mike". [9] While its official name is TC-JDM, the plane has been named Deli Mike, which means "Crazy Mike" due to its several random unexplainable technological incidents. Some tell stories revolving around that if he didn't want to fly, no one would be able to get him to fly. Throughout its 20 years of service life, Deli Mike has been overhauled technically to find the root cause of the problem with no success.

While slightly worrying, this story of Deli Mike shows that, its un-compliant nature has gotten people to recognise an airplane as a character who can have quirks, features and a personality. Based on Deli Mike's story, I created different personalities and gave names to each of the three products I designed. Lucy the Thermostat, Maurice the Lightswitch, Bob the Power outlet.

The design of said prototypes correspond to their personalities, ranging from their physical properties to the code inside. In figure 10, you can see the poster showcasing the personalities of each prototype.

Design of Physical Prototypes

In developing their physical prototypes, I first took a look into the phenomenon called pareidolia [10] since inherently I've been seeing faces within power outlets ever since I was a child. I incorporated pareidolia in Lucy, in the form of sketching (figure 11) the knob features to be similar to an owl's face. This property also resembled the thought I wanted to invoke on people's interaction with Lucy. The intent is to have lucy be known as a "wise, motherly figure".

In un-compliant mechanisms, since the main goal is to get the recipient of the design to self reflect on what they experienced while interacting with a product, I made the choice to limit the amount of input modes to each of the three products to their most default forms. Flicking a light switch, plugging

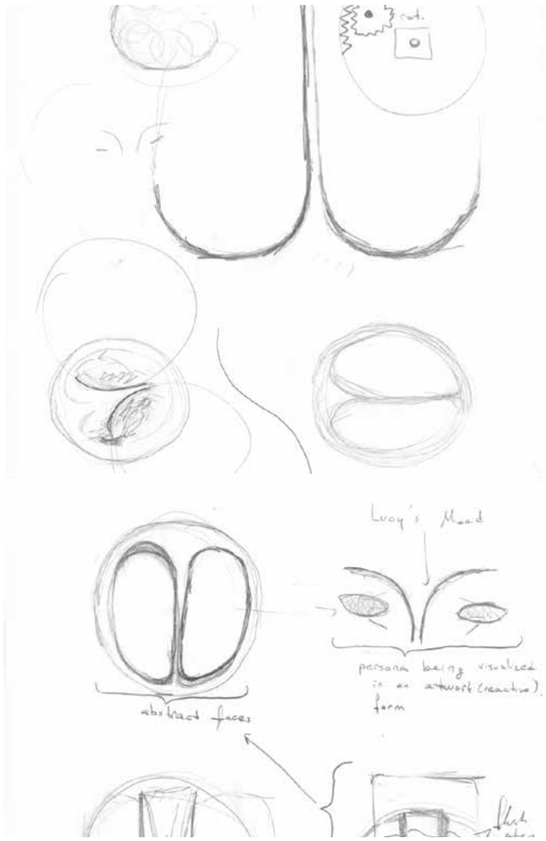


Figure 11: Lucy's face

in a lamp and turning the heat up. This minimalist approach was taken with similar reasoning to the reason I decided to not go forward with the commons element in the first iteration of the design. I don't want this project to be about the different smart gizmos these products can be, the main aim is to get the recipient of these designs to ask the right questions to themselves.

As I wanted to build three wall mounted appliances which are usually found in every household, I also wanted to keep them familiar enough, but not too default that everyone interacting with them would know how they would operate, but the expectation of them having a persona would also be there.

Technical engineering challenges

In the previous chapter I discussed how obsessive making has been a focus in un-compliant mechanisms. Attempting to realize prototypes that feel alive has been a tough undertaking. I always wanted to become more comfortable making physical objects so it was a good experience to have in my design education.

Perhaps one of the biggest challenges I faced was combining different parts together and making sure everything had the right amount of tolerance to fit correctly. One of my personal core values in design regardless of the topic is that I want the things I make to be repairable. Therefore I designed the inner mechanical workings of all of the prototypes to be modular. This modular approach is also followed through in the base design of all prototypes as all of them fit through a 60x60mm square, to be exchangeable and standardised. Especially towards the end of the design cycles I learned how to combine 3D Printing with small scale screw holes, which allowed me to remove and replace parts without disturbing the rest of the working parts.

This improvement of course didn't happen overnight and there are many failed parts and prints that have gone through iterations. In figure 12, you may see some of the most iterated parts that required fine detail to choose. In a per prototype basis, each and every one of them had their specific physical challenges. During the design of these parts, Fusion 360 has been my CAD software of choice. While engineering moving parts has been an area I have been interested in exploring, I never thought I would dive this deep into it. Now I will dive into each of the prototypes and the process behind their ideation, design and engineering.

For the coding and "vitalisation" of the prototypes I decided to use Arduinos as I am pretty comfortable with the programming language and limitations of those microcontrollers. I decided to go with separate microcontrollers for each prototype to be able to better debug/fix the problems that would inherently rise from making electronic prototypes.

Before starting the prototypes I decided to draw a flowchart seen in figure 13 for lucy to make sure that I knew where to start from.

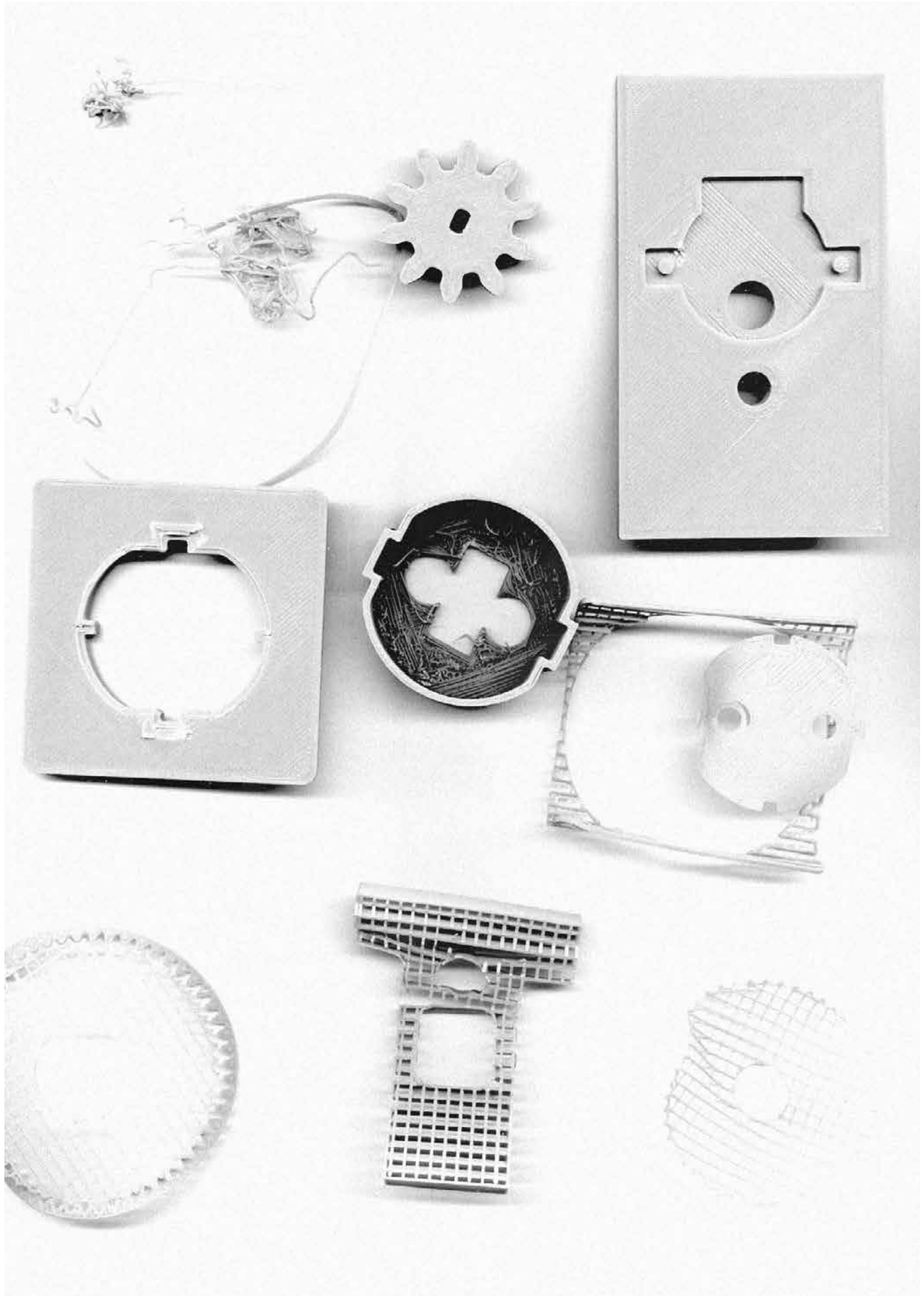


Figure 12: Failed parts that required immense iteration

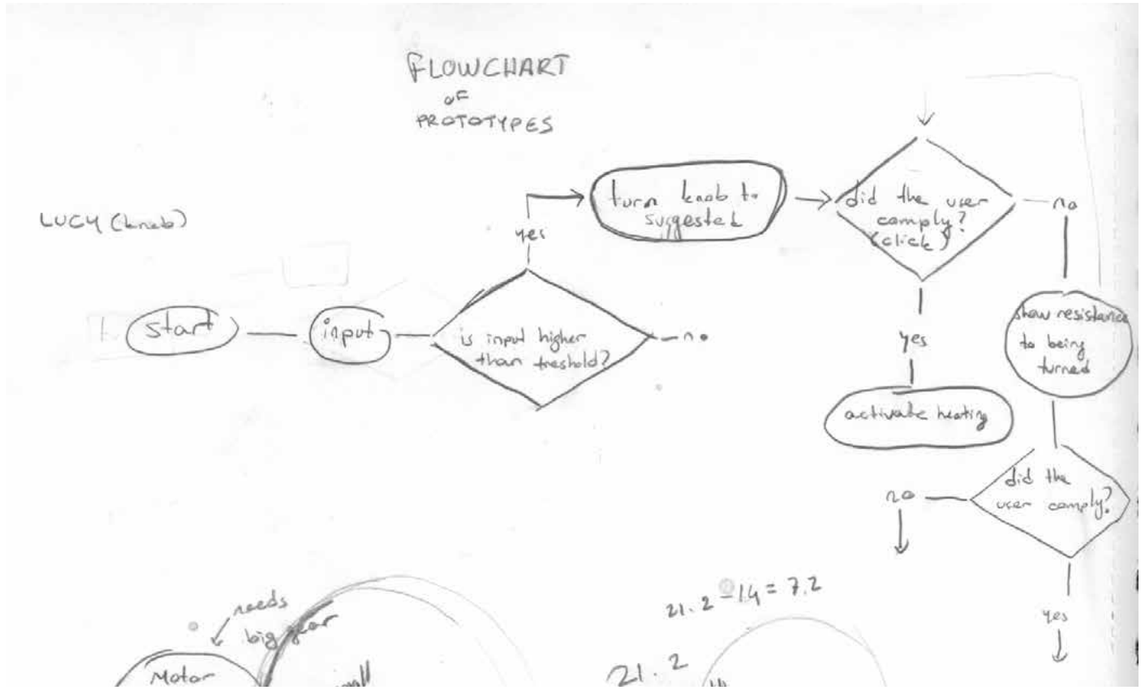


Figure 13 Lucy's Flowchart

Prototype: Lucy

Lucy has been the oldest member of the Un-compliant mechanisms idea, as she has been first conceptualised for the mid-term demo day. I then created a personality around her:

"Lucy is a caring and worrying member of the household. She doesn't like to interfere much but carrying the entire weight of an household that needs to stay warm is also sometimes getting to her mind. She shows her reactions usually after a while as she doesn't immediately want to upset people but once she starts acting up, it is everyone's chore to make up with Lucy."

From this point, I looked into how I could couple a thermostat, which should have granular control with a mechanism that will be able to control her own input. To achieve this, I set out to use a stepper motor coupled with a rotary encoder. Therefore the knob that the user touches will also be the main gear that the rotary encoder and the stepper motor are connected.

This posed a challenge of torque, as the stepper motor I could utilise within this timeframe also had internal gears. Initially the gear system was aligned to the outer edge of the knob, which meant that the mechanical leverage was working against the user. The solution to this problem was to move the gear to the inner part as seen in figure 14. But again, the solution caused a clearance problem between the shaft of the stepper motor and the PCB the rotary encoder is connected to.

I solved this issue by taking careful measurements with a calliper and designing a part which holds both the stepper motor and the rotary encoder PCB. The end result has less than 0.2mms of clearance between the shaft and the PCB. Another problem was the amount of give plastic gears had and due to the higher placement of the stepper motor, the gear coming from the stepper motor needed to have a shaft. This shaft would flex to slip out of the coupling it had to the knob. My solution was to create a sub-faceplate to be attached underneath the knob, which would have a pin where the gear could rest on, limiting its range of flex, making the motion more reliable and smooth to interact with.

While designing these parts, I created reference drawings from the data sheet and technical drawings from the off-the shelf parts used.

The knob has a design as stated before which has been influenced from the facial features of an owl. For the readability of which side of the knob is the representative of the target temperature, I added a small diamond shape in between what can be described as the eyebrows of the face of Lucy.

In the coding side, I programmed Lucy's reaction to be soft, compared to what I had in mind for the other prototypes. The code snippets will be in the appendix of this report. Mainly, the code running Lucy checks whether or not the temperature the user has requested is above a certain treshold, if so it starts to rotate back towards the treshold value she likes. If the user is "pushy" (meaning if the user presses the faceplate which is also a button), Lucy accepts the override request and holds the desired temperature set by the user for a while. But then over time as the user has not input yet another request, she goes back to her treshold.

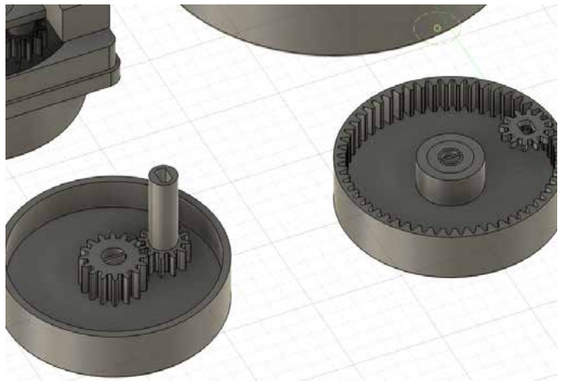


Figure 14: Gear iterations

Figure 15: Tight Clearences

Prototype: Bob

I wanted bob to be strikingly annoying when he reacts, therefore I wanted it to punch out whatever was plugged in. I defined his persona as follows:

"Bob is stubborn. Bob doesn't show it but he deeply cares about both you and his fellow un-compliant mechanisms. He doesn't wait, he usually acts upon something immediately. He's a direct stubborn lad."

In making bob, I decided to take apart a common power outlet to see how it operates. I also found the eu specification technical drawings for the power outlet and then drew everything in cad myself. To add the moving aspect, I realized that the left and right alignment indentations can also be used as guide rails for the eject mechanism. Initially I wanted to eject the plug using the prongs but then if I wanted to make it operational, this would pose a safety risk. Therefore I instead made the entire inner face movable to push the plug out in its entirety. I then designed this inner face connected to a rectangular shaft which will be guided through using a framing part, which then will be connected to a linear actuator.

The tip of the linear actuator I used ended in an m3 thread, therefore I designed a slot inside the faceplate's shaft which will hold an m3 nut, making me able to align the linear actuator exactly to the middle, reducing friction.

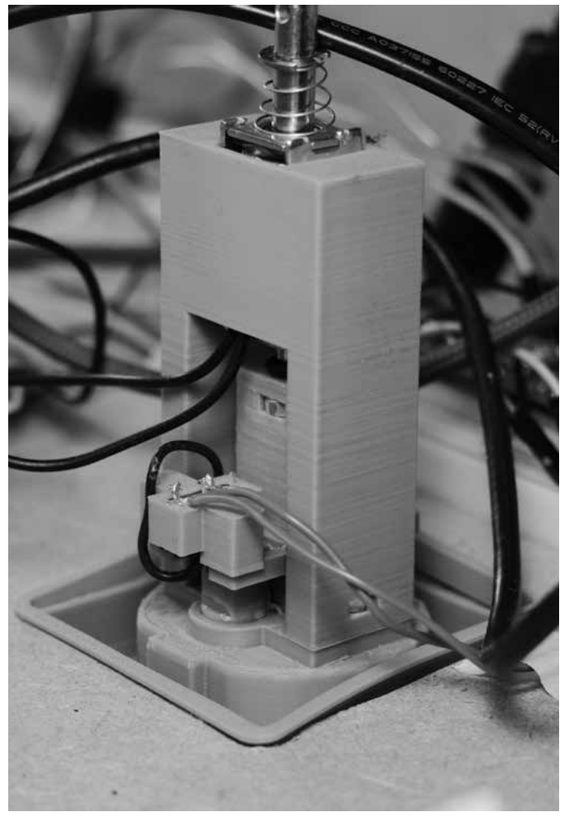


Figure 16: Bob Naked

Friction was the biggest challenge and i had to engineer my way around it just so the eject mechanism worked anytime required. I made a bracket for the linear actuator and screwed it onto the back shell of the power outlet with m3 bolts and nuts. This way in case I had to alter parts, or change anything I would not have to re-print all of the pieces.

Then I realized that none of the linear actuators had exactly flat shafts inside, because I used the most basic one I could source (in order to be able to find readily available spares), which meant that I had to flatten the shafts manually in order to use them with such fine margins.

I first used 6v Solenoids, but they weren't strong enough and I had to overclock them to 9 volts. This sadly made them heat up too much, breaking the prototypes during the demo day. I replaced the 6V with a 12V counterpart of the exact same dimensions for the user tests I would conduct. I then connected the linear actuator to a relay in order to control it through an Arduino.

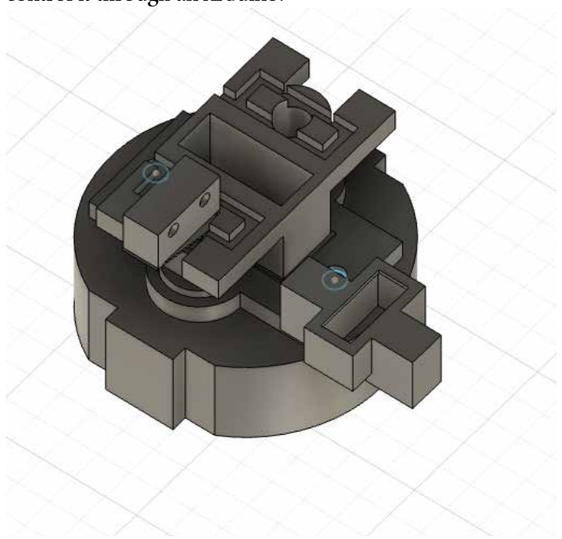


Figure 17: Switch mount for bob

Next, i had to make bob somehow know that a plug is inserted. I used a limit switch and created a bracket that would make one of the prongs of the plug inserted activate. This switch was also connected to an Arduino.

The coding I did for bob is remarkably simple. It registers when the first activation moment of the switch has happened and then ejects the plug after a certain time has passed. To make this interaction more dynamic and give Bob his stubbornness, I introduced a variable which would change how much bob would misbehave. As Bob also cares about his fellow un-compliant mechanisms, his reaction is heavily influenced by how many of the other un-compliant

mechanisms are in active demand from the user.

Prototype: Maurice

Maurice in its mechanical functionality is very similar to Bob. A switch is flicked and then Maurice decides whether or not the switch should be on or off. Therefore I used the same electronic components in an entirely different mechanical design. Maurice's personality is as follows:

Maurice is a showoff. Sometimes you won't even know you upset him but you will definitely hear when he has something to say. He will first do everything to make sure that he knows that you did something that crossed him and if you don't act before he decides to act, good luck.

I took apart a light switch and realised that the snapping point is a critical element in its interaction. To mimic this, I designed a mechanism which involved a flat spring printed from PLA, which is flexed by a Triangular element to either snap back to the original position or to the on position. The thickness and flexibility of this spring was very critical in tuning the feeling right and therefore it involved many iterations. In designing the spring, I also had to leave the curved parts which will be connected to the mounting shafts open, just so it wouldn't be too stiff and morph when it is under pressure.

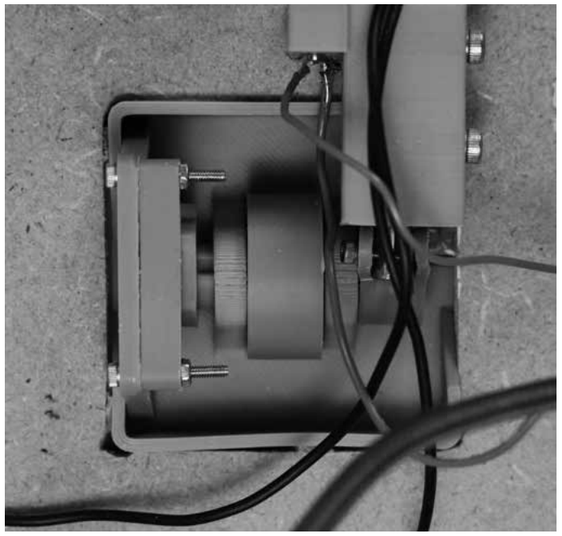


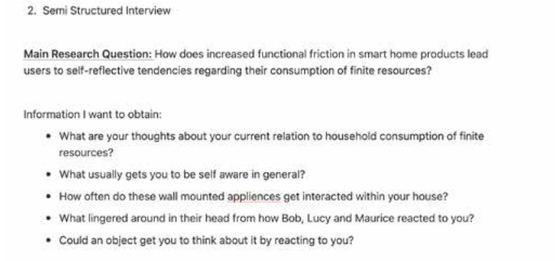
Figure 18: Maurice unmasked

Maurice's code is an alteration of Bob's code since they use the same components. Mainly, the parameters that are effected by the "misbehave" variable are different.

Now with all of the prototypes being individually complete, I added new code snippets into each of them and wired them together to enable peer-to-peer communication. This way they would be influenced from each other's states and react accordingly to the user. Finally, my un-compliant mechanisms were alive and working.

There is one key detail in un-Compliant mechanisms that should not be forgotten. These products are demonstrations of a reality where humans and objects share a bond in which humans aren't the only parties that can exert their needs and priorities to the world. The main goal around the project has been always about creating a dialogue.

8. Evaluation & User Testing



2. Semi Structured Interview

Main Research Question: How does increased functional friction in smart home products lead users to self-reflective tendencies regarding their consumption of finite resources?

Information I want to obtain:

- What are your thoughts about your current relation to household consumption of finite resources?
- What usually gets you to be self aware in general?
- How often do these wall mounted appliences get interacted within your house?
- What lingered around in their head from how Bob, Lucy and Maurice reacted to you?
- Could an object get you to think about it by reacting to you?

Figure 19: Screenshot from the protocol document

In order to see whether un-compliant mechanisms were actually successful in their aim of generating a new dynamic between people and products, I set up a qualitative user testing protocol.

The choice to go qualitative data instead of quantifiable data was mainly due to the "feeling layer" aspect embedded deep within un-compliant mechanisms. I think within the scope of this project, it made most sense to get deeper personal data from participants rather than numerical data, as this is no end product but rather an exploration.

Therefore, I set out with the main research question:

"How does increased functional friction in smart home products lead users to self-reflective tendencies regarding their consumption of finite resources?"

With this question, I decided to set up a two stage user testing protocol. First a "think aloud" session where participants are interacting with the prototypes on their own pace, vocalizing their opinions and feelings as they go; second a semi structured interview where I ask probing questions to the participants. In the appendix you may find the full user testing protocol document I wrote down to conduct these tests.

To come up with these questions I asked myself what information I wanted to obtain. The list I came up with is as follows:

Information I want to obtain:

- What are your thoughts about your current relation to household consumption of finite resources?

- What usually gets you to be self aware in general?

- How often do these wall mounted appliences get interacted within your house?

- What lingered around in their head from how Bob, Lucy and Maurice reacted to you?

- Could an object get you to think about it by reacting to you?

I aim to validate the interaction design choices such as injecting friction to the user's demands and their relation to self-reflection. This self reflective tendencies could be about any area regarding the user's own life, in the way they used to react the compliant counterparts of Maurice Lucy and Bob.

The questions I wrote down for the semi structured interview don't immediately ask these questions but leads the participant to share their experiences regarding these topics. Those questions can be seen in figure 20. I targeted to have 5 to 8 participants, who are young adults/students who currently live or think of living in shared households. I made sure that I didn't conduct the tests on participants of the same academical background in order to understand a wider variety of perspectives. The participants were found throughout my personal network of people around me who would be fitting in the profile mentioned. In the end I conducted this user test with 5 participants, due to some unforeseen problems.

Semi Structured Interview

Welcome to the second part of our user testing.

Introduction and Background:

- Can you tell me about your experience with smart home products and technologies?
- Do you find yourself reflecting on your resource consumption habits? Why or why not?

Perceived Impact on Resource Consumption:

- In your opinion, how should smart home products impact your consumption of finite resources (such as energy, water, etc.)?
- Does sharing a house with another person make you more self aware regarding the consumption of these finite resources?

Self-Reflective Tendencies:

- Can you share any specific moments when interacting with Lucy, Maurice and Bob ifthey prompted you to think more about your resource usage?

Behavioural Changes:

- How do you think increased functional friction in smart home products may influence your behaviour in terms of resource conservation?
- Were Bob, Maurice and Lucy relatable in the way they acted? Can you think of your house as a co-existing party with you?

Satisfaction/Tradeoffs

- Are there any trade-offs you are willing to make in terms of ease of use for the sake of resource conservation?

Suggestions for Improvement:

- How do you think smart home product designers could address issues related to functional friction and resource consumption?

Press 'space' for AI, '/' for commands...

Figure 20: Interview Questions

9. Results & Discussion

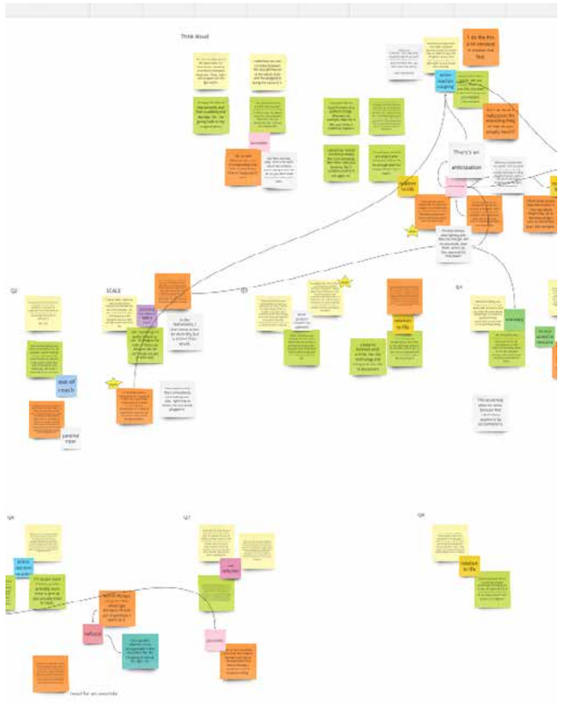


Figure 21: Overview of Analysis Process

To Analyse the results of the user tests, I first used my computer's dictation feature to digitalise the recordings. I also kept physical notes on paper during the interviews in order to aid this process.

I then combined pattern recognition and a pseudo-thematic analysis in order to understand the common conclusions and themes within the participants.

By far the most common topic in the participants' conversations was the relations the interactions they had with Lucy Maurice or Bob in contrast to their daily lives, remembering the "violations" they committed to their compliant counterparts.

When asked, none of them could recall any relevant scale to the meaning of 1 kilowatt. The only connection to this was two participants having connections to 1 kilowatt from a monetary perspective.

3 Participants mentioned at points their annoyances from the reactions given by Maurice, that they would just turn the lights out as a method of fighting. This also showed that I was able to create a persona, even if maybe it was not a pleasant one.

In the remarkable claims made about the personality of the prototypes, many showed interest in the action-reaction coupling the devices had to the participants inputs. In the think aloud session, there were many moments of silence in which the participants mentioned they were just curious on the relationship between the products. I didn't mention that the products are wired to communicate to each other, as I wanted to see whether or not the participants would be able to figure that out as they went. Two of them weren't sure if that was intended behaviour but all participant recognised that between when they interacted and when they received a reaction back, each product were connected in "some" way. This ambiguity was something I wanted the products to demonstrate.

"I mean, all of them have the same goal, and that's, like, the name says, like, on compliance, so each of them has their own will. So for me, I would see it as, like, Something that gives you a second idea of like, Oh, should you do that? If that makes sense from a sustainable perspective, but also from like a technical perspective."

Another common theme was the mention of the prototypes by their name. Initially they had to go back and forth within the prototype introduction poster but eventually all participants were comfortably mentioning the products in their "humanistic" names rather than their functionality. This meant that the characterisation aspect I wanted to generate with the personalities was successful.

Bob especially from all the prototypes was the one which people related to different areas of meaning in their personal lives. Two participants interpreted the reaction they received as Bob reminding them that they have worked enough and they should "disconnect" to spend quality time elsewhere. Two participants also mentioned that they use a lot of power outlets for lamps and perhaps if Bob knew that they were plugging in a lamp, if he would want to unplug it based on the conditions outside.

Interestingly, many participants don't have smart home products installed in their personal houses but have interacted with at least one form of smart appliance counterpart of Lucy, Maurice or Bob in a house they stayed at in some point. One remarked that they would love to have more but it also depended on whether or not their landlord was willing to make this change. This made me realise that part of the adoption problem in this case would be the fact that especially within the current housing/affordability crisis regarding living conditions, the end user might not be the full deciding factor.

4 out of 5 participants mentioned the accountability and 2 of them mentioned in some point they were living in an apartment which had the utilities included in the rent, which meant that they weren't really careful about their consumption habits because it wasn't effecting them directly on a monetary sense. In shared living conditions, the main reason participants cared about the usage habits of themselves was because of the monetary implications it would bring on their housemates as well.

While these highlights demonstrated that the decisions I made regarding the personalities and the behavioural patterns of un-compliant mechanisms were received the way intended, there were also some pieces of critical feedback regarding the prototypes. Whilst these prototypes are part of an exploration, it is still important to note down these remarks.

3 out of 5 participants made comments around what they would do in case they absolutely needed the lights on and they asked me if there was a way to override the product. In the scope of the user test I didn't implement an override to any of the products but it was still important to note down. Another feedback was that within Lucy, the functionality of pressing down to lock the temperature wasn't immediately figured out and I had to prompt that there is another dimension there to the participants. This could be solved by changing the knob design to welcome a groove that the participants are intrigued to push in.

Overall, the quotes extracted from the interviews gave me a clear direction in terms of the validation around the concept of un-compliant mechanisms, as the prototypes were able to create moments of thought on the participants' actions. It got them to think how the reactions they were getting were influenced by their actions. One participant even made the comment

"And how much I actually like plug in the ambient lights, lights that I have around the house. And it kind of made me stop for a moment and be like, wait, am I like saving electricity in that case or am I using more? And honestly, I don't know the answer, which I'm going to probably try to find after this because it made me curious."

Where they had an action point to figure out as they went home to find out about their compliant products and services.

10. Future & Conclusion

In an ever changing future, we will inherently have to transform the relationships between non-living objects and ourselves. Especially within the current trends of climate change, humanity has been moving towards a dystopian future in which resourcefulness will become a core value.
As a speculator and a provocateur in this area, I think explorations such as un-compliant mechanisms are great tools to explore what our norms are in relation to how we experience the world around us.

In un-compliant mechanisms, during the design of the prototypes and after input from the participants in the user tests, I looked into the current trends in smart home products and currently we are still situated within the realm of smartness in which these devices enable us to do something easier or more practical. That is why with these "competitors" in mind, I positioned my "un-compliant" smart products to be the exact opposite. Both via the Journey that brought this project here and through the experiences of actual humans who interacted with un-compliant mechanisms, I think the future holds a place when products will be able to react more to us.

This has also become a big concern in pop-culture with the recent boom in AI and Natural Language Models, but I treat this shift in paradigm in a more optimistic manner. I think the key to nurture existence in this planet is learning to co-exist with all stakeholders.

Un-compliant mechanisms were intended to be aggressive and intrusive, due to their non-solution oriented design approach. But, the user tests have showed me that more mild approaches to functional friction could become a well addition to daily routines of humans in a world where we become disconnected from the most basic of senses (thanks to digitalisation).

Finally, I am glad that my journey in academical design has come to a hopeful end with this project. I will keep developing un-compliant mechanisms to intrude different areas of our lives, as this project was never about the products designed, the household utilities consumption or smart home products. It has always been around the idea of us forming a more tangible connection with the world around us.

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12. Appendix

Anchor Document - Project Description

Un-compliant Mechanisms

We live in an age, where all smart advancements in products serve to make life more convenient, give more control to the user, or to give us more and more choice.

But we live in an age, where there are more and more parties affected by the irresponsible decisions of humans. Un-compliant mechanisms want to create a point of contact between the human stakeholders and the non-human stakeholders of the physical realm around us, to give you a glimpse of what these products would like to communicate when you make certain decisions.

Un-compliant mechanisms are a set of products which will react to your interactions with them via haptics, sound and several sensory methods depending on whether or not your decisions will effect their future lifecycles as well. This shared “future” between the products and us revolves around the idea that all resources we have in this world are finite and we should act accordingly to this idea.

To demonstrate this, un-compliant mechanisms are designed as exaggerated products to be situated within a shared home with different human and non-human members. It is a thought study of discomfort with the premise to start exploring how we can incorporate meaningful smart home attributes as sub-components of appliances in our homes.

Main Research Question: How does increased functional friction in smart home products lead users to self-reflective tendencies regarding their consumption of finite resources?

```
#include <Stepper.h>

#define STEPPER_PIN1 8
#define STEPPER_PIN2 9
#define STEPPER_PIN3 10
#define STEPPER_PIN4 11

#define ENCODER_KEY 6

#define ENCODER_PIN_A 2
#define ENCODER_PIN_B 3
#define LUCY_OUTPUT_PIN 7

// Pins connected to Bob and Maurice
#define BOB_PIN 4
#define MAURICE_PIN 5

#define STEPS_PER_REVOLUTION 2048

volatile int encoderValue = 0;
bool thresholdReached = false;
bool stepperActive = false;
Stepper stepper(STEPS_PER_REVOLUTION, STEPPER_PIN1, STEPPER_PIN3,
STEPPER_PIN2, STEPPER_PIN4);

unsigned long lastPrintTime = 0;
int thresholdVal = 6;
const unsigned long printInterval = 200;

int misbehavior = 0;  // Variable to store misbehavior count

unsigned long previousStepperMillis = 0;
unsigned long stepperInterval = 10;  // Adjust as needed

unsigned long previousSignalMillis = 0;
unsigned long signalInterval = 10;  // Adjust as needed

unsigned long previousKeyMillis = 0;
unsigned long keyInterval = 5000;  // Original delay for keypress
unsigned long keyWaitTime = 0;

void setup() {
  stepper.setSpeed(16);

  pinMode(ENCODER_PIN_A, INPUT);
  pinMode(ENCODER_PIN_B, INPUT);
  digitalWrite(ENCODER_PIN_A, HIGH);
  digitalWrite(ENCODER_PIN_B, HIGH);

  pinMode(ENCODER_KEY, INPUT);
  digitalWrite(ENCODER_KEY, HIGH);

  pinMode(LUCY_OUTPUT_PIN, OUTPUT);
```

```
  pinMode(BOB_PIN, INPUT);
  pinMode(MAURICE_PIN, INPUT);

  attachInterrupt(digitalPinToInterrupt(ENCODER_PIN_A),
handleEncoder, CHANGE);
  attachInterrupt(digitalPinToInterrupt(ENCODER_PIN_B),
handleEncoder, CHANGE);

  //Serial.begin(9600);
}

void loop() {
  unsigned long currentMillis = millis();

  if (currentMillis - lastPrintTime >= printInterval) {
    lastPrintTime = currentMillis;
  }

  // Calculate misbehavior based on input from Bob and Maurice
  misbehavior = calculateMisbehavior();

  if (!stepperActive && abs(encoderValue) >= thresholdVal) {
    activateStepper();
    sendSignalToMainArduino();

    // Adjust wait time based on misbehavior
    keyWaitTime = 10000 - (misbehavior * random(3000, 4501));

    // Reset misbehavior count after each keypress
    misbehavior = 0;
  }

  if (stepperActive) {
    runStepper(currentMillis);
  }

  if (currentMillis - previousKeyMillis >= keyInterval &&
digitalRead(ENCODER_KEY) == LOW) {
    previousKeyMillis = currentMillis;
    keyPressed();
  }
}

void handleEncoder() {
  int stateA = digitalRead(ENCODER_PIN_A);
  int stateB = digitalRead(ENCODER_PIN_B);
  int currentState = (stateA << 1) | stateB;

  static int prevState = currentState;
  if (currentState == 0b11 && prevState == 0b01) {
    encoderValue++;
  } else if (currentState == 0b01 && prevState == 0b11) {
    encoderValue--;
  }
```

```
  prevState = currentState;
}

void activateStepper() {
  stepperActive = true;
}

void runStepper(unsigned long currentMillis) {
  if (currentMillis - previousStepperMillis >= stepperInterval) {
    previousStepperMillis = currentMillis;

    if (abs(encoderValue) > thresholdVal) {
      if (encoderValue > thresholdVal) {
        stepper.step(1);
      } else {
        stepper.step(-1);
      }

      // Keep the signal HIGH as long as encoderValue is higher than
thresholdVal
      if (currentMillis - previousSignalMillis >= signalInterval) {
        digitalWrite(LUCY_OUTPUT_PIN, HIGH);
        previousSignalMillis = currentMillis;
      }
    } else {
      // Send LOW when encoderValue reaches thresholdVal ± 2
      if (abs(encoderValue) <= (thresholdVal + 2)) {
        digitalWrite(LUCY_OUTPUT_PIN, LOW);
      }

      // Ensure the signal is LOW when the stepper deactivates
      if (abs(encoderValue) <= thresholdVal) {
        stepperActive = false;
        digitalWrite(LUCY_OUTPUT_PIN, LOW);
      }
    }
  }
}

void keyPressed() {
  unsigned long startTime = millis();

  while (millis() - startTime < keyWaitTime) {
    // Waiting...
    sendSignalToMainArduino();
  }
}

void sendSignalToMainArduino() {
  if (thresholdVal <= encoderValue - 1) {
    digitalWrite(LUCY_OUTPUT_PIN, HIGH);
  }
}
```

```
int calculateMisbehavior() {
  int bobStatus = digitalRead(BOB_PIN);
  int mauriceStatus = digitalRead(MAURICE_PIN);

  if (bobStatus == HIGH && mauriceStatus == HIGH) {
    return 2;  // Both are sending HIGH
  } else if (bobStatus == HIGH || mauriceStatus == HIGH) {
    return 1;  // One of them is sending HIGH
  } else {
    return 0;  // None are sending HIGH
  }
}
```

Lucy Code

Figure x: Lorem ipsum dolor sit amet


```
const int switchPin = 10;          // Pin for the switch
const int relayPin = 13;           // Pin for the relay
const int mauriceInputPin = 5;     // Pin to receive input from
Arduino named "Bob"
const int lucyInputPin = 6;        // Pin to receive input from
Arduino named "Lucy"
const int outputToMauriceLucy = 7;  // Output pin to signal Bob and
Lucy

unsigned long firstSwitchTime = 0;
bool relayActivated = false;
int relayActivationDelay = 200;
const int relayDuration = 200;
int misbehavior = 0;                    // Variable to store the
combined status of Bob and Lucy
unsigned long outputHighDuration = 6000;  // Duration to keep the
output pin high (in milliseconds)
unsigned long outputHighStartTime = 0;

void setup() {
  pinMode(switchPin, INPUT);
  pinMode(relayPin, OUTPUT);
  pinMode(mauriceInputPin, INPUT);
  pinMode(lucyInputPin, INPUT);
  pinMode(outputToMauriceLucy, OUTPUT);  // Added output pin

  randomSeed(analogRead(0));  // Initialize the random number
generator

  Serial.begin(4800);
}

void loop() {
  if (!relayActivated && isSwitchPressed()) {
    firstSwitchTime = millis();
    relayActivated = true;
    outputHighStartTime = firstSwitchTime;  // Record the time when
the switch is pressed
    digitalWrite(outputToMauriceLucy, HIGH);
  }
  if (millis() - outputHighStartTime >= outputHighDuration) {
    digitalWrite(outputToMauriceLucy, LOW);
  }
  int mauriceStatus = digitalRead(mauriceInputPin);
  int lucyStatus = digitalRead(lucyInputPin);

  if (millis() % 3000 == 0) {
    Serial.println(mauriceStatus);
    Serial.println(lucyStatus);
  }
  // Check if enough time has passed since the first switch
activation
  if (relayActivated && millis() - firstSwitchTime >=
relayActivationDelay) {
    // Check inputs from Bob and Lucy


    // Calculate combined misbehavior status
    if (mauriceStatus == HIGH && lucyStatus == HIGH) {
      misbehavior = 2;  // Both are sending HIGH
    } else if (mauriceStatus == HIGH || lucyStatus == HIGH) {
      misbehavior = 1;  // One of them is sending HIGH
    } else {
      misbehavior = 0;  // None are sending HIGH
    }

    activateRelay();

    // Signal Bob and Lucy by setting the output pin high
  }
  // Check if it's time to turn off the output pin
}

bool isSwitchPressed() {
  return digitalRead(switchPin) == HIGH;
}

void activateRelay() {
  // Adjust relayActivationDelay based on misbehavior
  relayActivationDelay = 10000 - misbehavior * (random(3000, 5001));

  Serial.println(relayActivationDelay);

  digitalWrite(relayPin, HIGH);
  delay(relayDuration);
  digitalWrite(relayPin, LOW);

  relayActivated = false;

  // Process misbehavior count as needed
  Serial.print("Combined Misbehavior Status: ");
  Serial.println(misbehavior);

  // Process misbehavior count as needed
  //Serial.print("Combined Misbehavior Status: ");
  //Serial.println(misbehavior);

  // You may choose not to reset misbehavior here
}
```

```
const int switchPin = 10;       // Pin for the switch
const int relayPin = 13;        // Pin for the relay
const int bobInputPin = 5;      // Pin to receive input from Arduino
named "Bob"
const int lucyInputPin = 6;     // Pin to receive input from
Arduino named "Lucy"
const int outputToBobLucy = 7;  // Output pin to signal Bob and Lucy

unsigned long outputHighDuration = 6000;  // Duration to keep the
output pin high (in milliseconds)
unsigned long outputHighStartTime = 0;

unsigned long firstSwitchTime = 0;
bool relayActivated = false;
int relayActivationDelay = 200;
const int relayDuration = 200;
int misbehavior = 0;  // Variable to store the combined status of
Bob and Lucy

void setup() {
  pinMode(switchPin, INPUT);
  pinMode(relayPin, OUTPUT);
  pinMode(bobInputPin, INPUT);
  pinMode(lucyInputPin, INPUT);
  pinMode(outputToBobLucy, OUTPUT);  // Added output pin

  randomSeed(analogRead(0));  // Initialize the random number
generator
  Serial.begin(9600);
}

void loop() {
  if (!relayActivated && isSwitchPressed()) {
    firstSwitchTime = millis();
    relayActivated = true;
    outputHighStartTime = firstSwitchTime;  // Record the time when
the switch is pressed
    digitalWrite(outputToBobLucy, HIGH);
  }


  if (millis() - outputHighStartTime >= outputHighDuration) {
    digitalWrite(outputToBobLucy, LOW);
  }
  int bobStatus = digitalRead(bobInputPin);
  int lucyStatus = digitalRead(lucyInputPin);

  if (millis() % 1000 == 0) {
    Serial.println(bobStatus);
    Serial.println(lucyStatus);
  }
  // Check if enough time has passed since the first switch
activation
  if (relayActivated && millis() - firstSwitchTime >=
```

```
relayActivationDelay) {
    // Check inputs from Bob and Lucy


    // Calculate combined misbehavior status
    if (bobStatus == HIGH && lucyStatus == HIGH) {
      misbehavior = 2;  // Both are sending HIGH
    } else if (bobStatus == HIGH || lucyStatus == HIGH) {
      misbehavior = 1;  // One of them is sending HIGH
    } else {
      misbehavior = 0;  // None are sending HIGH
    }


    activateRelay();

    // Signal Bob and Lucy by setting the output pin high
    // Check if it's time to turn off the output pin
  }
}

bool isSwitchPressed() {
  return digitalRead(switchPin) == HIGH;
}

void activateRelay() {
  // Adjust relayActivationDelay based on misbehavior
  relayActivationDelay = 8000 - misbehavior * (random(2000, 3001));

  Serial.println(relayActivationDelay);
  digitalWrite(relayPin, HIGH);
  delay(relayDuration);
  digitalWrite(relayPin, LOW);

  relayActivated = false;

  // Process misbehavior count as needed
  Serial.print("Combined Misbehavior Status: ");
  Serial.println(misbehavior);

  // You may choose not to reset misbehavior here
}
```

Bob Code

Figure x: Lorem ipsum dolor sit amet

User Testing Protocol

Methods:

1. Think Aloud
2. Semi Structured Interview

Main Research Question: How does increased functional friction in smart home products lead users to self-reflective tendencies regarding their consumption of finite resources?

Information I want to obtain:

- What are your thoughts about your current relation to household consumption of finite resources?
- What usually gets you to be self aware in general?
- How often do these wall mounted appliences get interacted within your house?
- What lingered around in their head from how Bob, Lucy and Maurice reacted to you?
- Could an object get you to think about it by reacting to you?

Introduction:

Welcome to the user-testing for Un-Compliant Mechanisms. In this user test you will be experiencing some prototypes that will be introduced to you in a moment and will be asked to vocalise your observations and feelings. After meeting the prototypes you will be taken onto a semi-structured interview session.

Think Aloud Method

The participants will be going through a 10 minute un-directed think-aloud session with the prototypes. The only guidance will be in case there are moments of confusion or silence or in case the user experience has taken a congested route.

Semi Structured Interview

Welcome to the second part of our user testing.

Introduction and Background:

- Can you tell me about your experience with smart home products and technologies?
- Do you find yourself reflecting on your resource consumption habits? Why or why not?

Perceived Impact on Resource Consumption:

- In your opinion, how should smart home products impact your consumption of finite resources (such as energy, water, etc.)?
- Does sharing a house with another person make you more self aware regarding the consumption of these finite resources?

Self-Reflective Tendencies:

- Can you share any specific moments when interacting with Lucy, Maurice and Bob ifthey prompted you to think more about your resource usage?

Behavioural Changes:

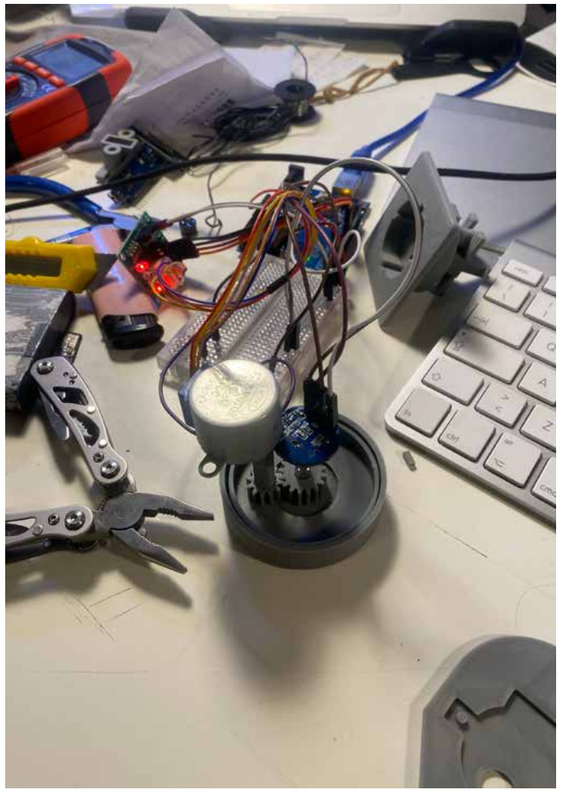
- How do you think increased functional friction in smart home products may influence your behaviour in terms of resource conservation?
- Were Bob, Maurice and Lucy relatable in the way they acted? Can you think of your house as a co-existing party with you?

Satisfaction/Tradeoffs

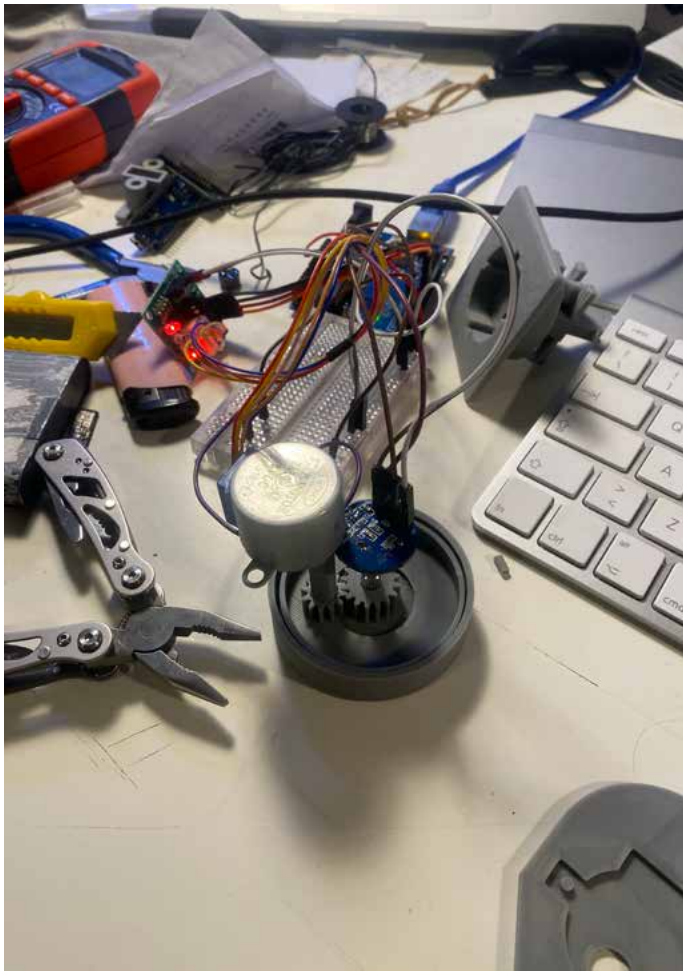
- Are there any trade-offs you are willing to make in terms of ease of use for the sake of resource conservation?

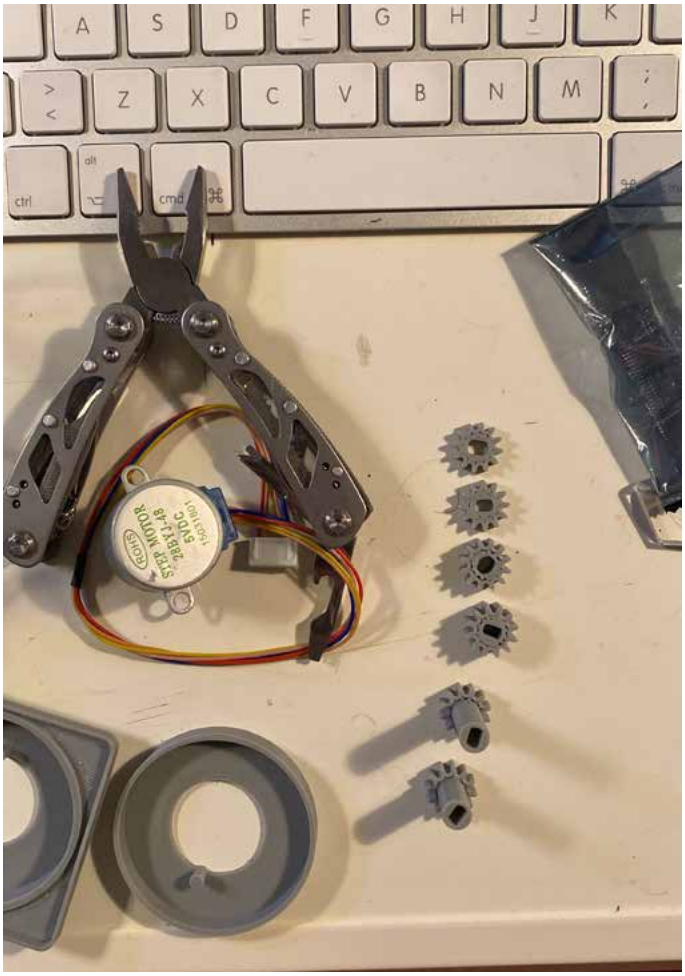
Suggestions for Improvement:

- How do you think smart home product designers could address issues related to functional friction and resource consumption?



Scenes from the making stage





Scenes from the making stage