DCM110

A Designerly perspective on the Internet of Things

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INTRODUCTION

Design of digital products, and in particular of IoT system products, has become mostly focused on employing screen or voice controls. These controls target the cognitive perception of users by the implementation of, among other, iconography, light signals and sound feedback in various forms and combinations. However, research shows that theories of embodied (Dourish, 2001 and 2004) and rich interaction (Frens, 2006) could be applied to the design IoT systems for a better user experience.

During this course we try to explore the possibilities of integrating tangible, rich and embodied interaction to IoT systems in a set of design exercises as well as literature. We examine the ways how various aspects of digital products can be coupled in order to create a growing IoT system, which provides meaningful and rich experience.

In this essay we will explain the process that we went through and the concepts that we designed, followed by our interpretation of the literature and how we implemented this in the design.

EXPERIMENTAL DESIGN JOURNEY

Design for rich interaction in home IoT

In assignment 2, 'Uclean', a management system for scheduling the cleaning tasks in a friendly student house, was designed to improve the communication issues between roommates. As shown in Figure 1, it is composed of two parts, a display device and a sticker for control. In the display device, a round-shaped card presenting roommates' names in the center, while a series of ring-shaped modules with incremental sizes indicate the cleaning tasks in shared spaces and the time to clean. The smallest module represents to the easiest task set by its users. A bigger module means a harder cleaning task. Each module also is marked into seven equal intervals, except the start and end points, which indicate how long do they need to do the task. Users can set how often they need to do the task through setting the endpoint. For instance, if there are 2 intervals from the start point to the end point, it means this cleaning task needs to be done every 2 days. Furthermore, the start point of the module aligns to the name of the person who did the task last time automatically. In this way, we want them to generate slight peer pressure on cleaning the shared rooms with their roommates. In addition, through a red coin that can automatically move on the track, users can get a sense of how long they haven't done the task. When it reaches the end point, it means the task needs to be done as soon as possible.

In terms of the stickers, they are the main input parts in the system which are composed by a name card and a ring-shaped module. On the one hand, stickers have the same function in conveying information to users visually. Each sticker connects and corresponds to a module in the display device. They also show what the display device shows, but separately, as they need to be set up beside the location of the task. On the other hand, stickers can be controlled and operated by users. Once they complete the task, they can rotate the module on the sticker to align the start point to their names, which indicates they just did the task, and swipe the coin back to the start point to indicate the timer is back to 0. Simultaneously, the corresponding module on the display device would be rotated to the name and refreshed the time of the task.

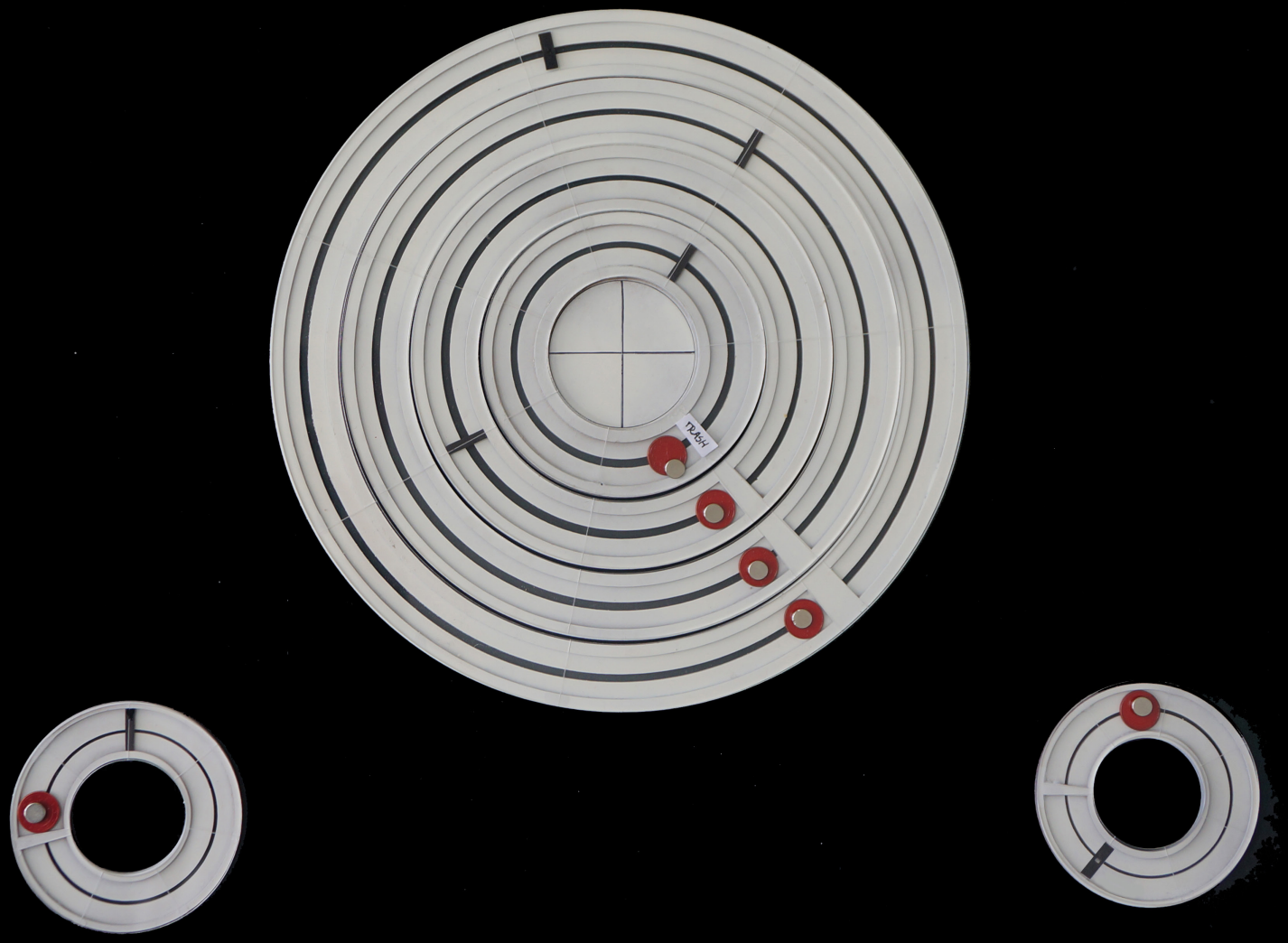

Figure 1: First iteration of 'Uclean'

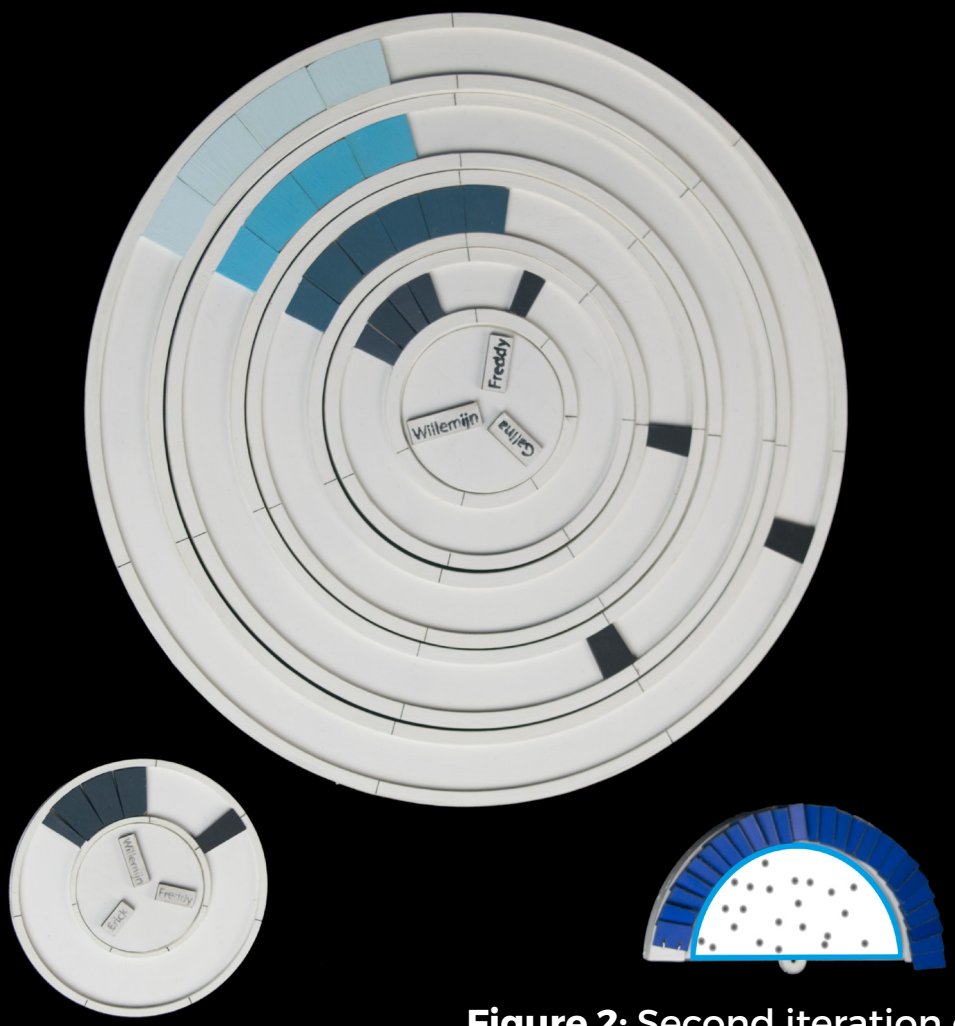

Figure 2: Second iteration of 'Uclean'

EXPERIMENTAL DESIGN JOURNEY

Design for rich interaction in growing IoT

Based on the feedback and advice for the first concept from the class, we updated the design of 'Uclean'. Besides, to develop our design into a growing system, we also incorporated a new home functionality, 'air quality', with the previous focus, 'communication'. As shown in the Figure 2, the system contents two concepts, 'Uclean' and 'WeVent'.
The main function of 'Uclean' isn't changed. What we improved are the forms to convey the information to users and the interactions. First of all, instead of the moving of the red coins, we show the time of tasks through the filling of color bars . The full ring would be 7 days, while each bar and ring represent one task. With the filling of bars, it provides an expression of time to users. In addition, color coding plays an important role in discovering the connection between the display device and the stickers without the label of tasks. It's easier for users to find the corresponding modules on the display device through comparing the colors.

In response, 'WeVent' contains two parts, the vent controller and the air quality monitor which is shown in Figure 3. The vent controller is represented by the half circle of blue lamellas on the display. Through swiping it, users can control the power degree of the vent in their rooms. When it's all dark blue, it means the vent is open in maximum power. Correspondingly, full of light blue indicates the vent is closed. During the process of cleaning, the room would become dusty/clogged with chemicals easily. When the device monitors bad air quality, the vent would be switched on automatically to the right power for the right amount of time. Certainly, users can control the vent freely if they choose to. Besides that, the smaller half circle in 'WeVent' is the display providing visual feedback in the form of an animation of air quality to users. The number of dots of the animation reveals how clogged the airs is. When the air quality becomes bad, the number of dots would be increased, and the color of the screen would shift from blue to red. Furthermore, the stickers can be attached on the 'WeVent'. As the number of vents in normal houses is not as many as the number of tasks, not every sticker needs to be attached to the 'WeVent'

Figure 3: Prototype of 'WeVent'

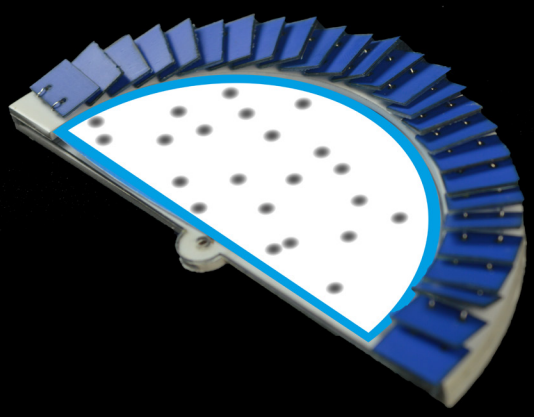

Figure 4: Integration 'Uclean' and 'WeVent'

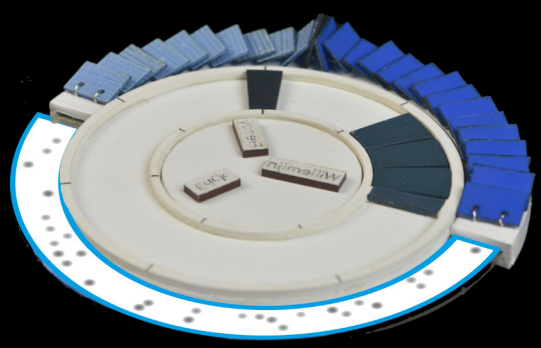

Figure 5: ‘Uclean’ in context

Figure 6: ‘Uclean’ sticker in context

TANGIBLE INTERACTION

Tangible interaction is the interaction style which uses physical objects to interact with computer systems (Frens, 2006). It is based on the notion that interactive products should respect all human skills and that in the recent development of the former, sensorimotor skills are almost not targeted (Overbeeke et al., 1999). The main goal of tangible interaction is to lessen the procedures which users have to go through (and remember) in order to use a product. Connecting digital information to tangible objects depends on the type of the information and the perceived meaning of the object.

There are several different types of information that we wanted to communicate in the uClean design. Those are indication that a task is done; the elapse of time; limit of the time for a particular task; separation of tasks; people who participate in performing tasks; and connection between task and person. We decided to implement a circular form design (fig. 2), which would be mounted on a wall. The design includes disks of different diameters (each disk represents one task) that are rotatable on one axis and an immovable central spot. After proposals of ideas and some discussion, it was concluded that the circular form communicates that the uClean stickers have time-based functionality and invite for rotational movements to match the outer disk (task) with the inner one (person). Furthermore, the swiping away motion connects to the understanding that the task is "cleaned".

For the vent installation product, the aim was to communicate that there is a direct control to the power of ventilation. The WeVent design followed with the circular shape (fig.3) of the uClean. Additionally, to convey the link to the vent functionality a lamellas mechanism was adopted. As with the Uclean sticker, it has a limit to which it can be physically pushed to and materializes the notion that the vent power can be gradually opened and closed.

RICH INTERACTION

Rich interaction integrates the form, interaction, and function of the product and provides rich action possibilities to design an aesthetic experience to users when they use the product (Frens, 2006). The product has three properties: form, interaction, and function. In rich interaction, what makes it more rich during use is the connection between each property. In the process of assignment 2 and 3, actually, we are mainly answering the following questions through our design:

- How does the shape (form) of the design embody its function?
- How does interaction relate to its function?
- How does the design provide rich action possibilities to users during use?

For our concept, it reveals rich relation between its form and interaction. In assignment 2, we defined to design a round-shaped device to express who did what and how often the tasks need to be done. To convey this information, we were not only designing a way to indicate time, but also providing a feeling of sharing and unity. It is easy for users to connect the round shape to time because of the cultural convention (Norman, D. A., 1999) that time is represented circularly: the clock, annual ring, and planetary trajectory. However, according to the feedback from class, we found that with the moving coins it is hard to show time is passing because the movement is slow and small. To make the concept more rich, we improved it in the third assignment, where we designed colored fillers to show the time instead of red coins.

In response, WeVent's core functions are showing the air quality to users and controlling the vents in the house. Through the visualization of the air quality on the display, users can clearly understand how dusty it is from the density of grey dots and how bad it is from the color of the display. In addition, we designed the vent controller into many small lamellas to provide a feeling on how much they open. The lamellas not only present how much the vent opens, but also provide a tangible feeling of turning on and off. After users control the vent through WeVent, the display can provide an augmented feedback regarding the process of improving the air quality.

In general, we provide rich relation between interaction and function to users in order to provide an aesthetic experience to them. They can rotate the ring module in stickers to align to their names after they finished the tasks. As the tasks in a shared room shouldn't always be done by one person, the action of rotating becomes meaningful, which provides a feeling of responsibility on cleaning the shared space. Furthermore, swiping the lamellas on WeVent not only gives functional feedback on turning on and off, but also provides augmented feedback on how powerful it is now. When going into auto mode, the screen provides meaningful feedback through unity of direction and time (Djajadiningrat, T. et. al., 2002): the user swipes the

timer to 0 from left to right indicating the task was done - the screen then freezes from left to right matching the user action and showing the auto mode triggered.

DESIGNING FUNCTION

SYSTEM PARAMETERS VS. PARAMETERS OF USE

There are two different aspects when it comes to function according to Frens (Frens, J., 2006): system parameters and parameters-of-use. On one hand, system parameters represent the "inflexible" functionalities programmed in the hardware of the product. On the other hand, the parameters-of-use represent the noticeable functionalities which are accessible to the user. The challenge is represented by translating the system parameters into parameters-of-use in such a way that it respects human skills.

In this section, we will point out the system parameters and the parameters-of-use for our products and the choices we made in order to make meaningful translations from the first to the second.

In the case of the core functionalities of Uclean, the system parameters coincide with the parameters of use: setting the number of housemates, setting the timer of a task, indicating the task is done, indicating who did the task, adding and removing tasks. Only two system parameters are automated in order for the user to have complete control over monitoring their own cleaning activity in the moment and making them more conscious about the achievement of completing a cleaning task. The system parameters that are automated are the points added to the account of a user and the time when a notification is sent to the user. Once an account holder

indicates the task has been done by her, the system automatically adds points to their account. Points cannot be added or removed by the user (without completing a task), therefore, no parameters of use are available. The reason is purely ethical, in order to avoid fraud. Notifications are also sent automatically by the system, without having parameters of use for enabling and disabling them, to avoid having users run away from the reminders when they have not cleaned in a long time.

When talking about the translation between the system parameters and the parameters for use, the meaningfulness of the mapping posed some challenges for us because of the abstract nature of the functionalities. Setting the timer, for example, is available to the user by means of a black "stopper" which can be rotated around a circular timeframe with seven slots indicating seven days. The "pushing" of the stopper gives visual as well as tactile feedback about how much time a task takes to be redone. Choosing the number of the housemates, on the other hand, does not include much human skill as it is done through the app and by simply choosing middle circles with the corresponding number of slots.

Moving on to the core functionality of WeVent, The system parameter of vent power is the same with the parameter of use. The translation between the two is meaningful as the user literally opens more lamellas with the controls in order to supply more power to the vents in the ceiling, just like one would do with the old school lamellar vents. This also gives visual feedback to the user through the control itself (open lamellas are a more intense blue). Moreover, it is a very satisfying tactile way of controlling the power. The display of WeVent is animated based on real values of volatile organic compounds, CO and mold, and, thus, they are system parameters which cannot be controlled or automated.

When talking about the emergent functionality between the two, the system parameters are completely automated, unless the user decides differently. Once uClean and WeVent are coupled, the parameter for use becomes indicating a task is done. This triggers the system parameter of the vent power to be automated. However, the user still has the freedom to control the power of the vent through the parameters of use – use the lamella controls to change the automated parameters.

DISTRIBUTED VS CENTRALIZED

According to Frens and Overbeeke (Frens, J. and Overbeeke, C.J., 2009), one important aspect when designing growing, interactive systems is looking at how one can interact and control the functionalities of the system once the components of the system move away from sight.

Even though in our system the components are not hidden, they are placed at different eye levels and at different locations – the main display of Uclean is placed in the living area while the stickers (controls) are placed all over the house; the vents of a room are most of the times placed in the ceiling, out of the sight and reach of the user. Centralized controls concentrate the authority of control in one central place while distributed controls enable the user to control the system from multiple locations (Merriam-Webster, n.d.).

When looking at Uclean, one can clearly say that there is a combination of distributed and centralized controls. Each sticker is placed in a different room, or in a different location of the room. However, all of them control the main display, as well as send data to the mobile application. This is an example of distributed controls. This is way more convenient for the user than our initial version of the design where the display was the centralized control for the stickers when indicating who completed the task. In the final scenario, the user does not have to walk in the living room everytime she has to indicate she completed a task. Instead, she can do that at the locus of the cleaning action. On the other hand, when buying the product, the user will initially set the number of the housemates and their account names from one mobile, making the controls in the application, in this case, centralized controls. This is preferred because, clearly, it would be very confusing for the system if the initial settings would be performed from multiple applications at the same time.

Regarding WeVent, the same pattern unravels: each WeVent device which is placed in a room can control all the vents in that specific room – this makes each WeVent device a centralized control for the vents of one room. However, because for each room one WeVent is needed, WeVent becomes a decentralized control for the vents of the whole house. A centralized vent controller for the whole house would be inconvenient because of the different size each room has and the different temperature and noise preferences for each room – e.g. the living room has to be more silent and warmer than the hallway, so different powers of ventilation are needed.
When talking about the whole system, Uclean coupled with WeVent, we have a combination of centralized and distributed, as well. Any sticker in the room can trigger the auto mode of WeVent, therefore, being distributed controls. However, the auto mode of the WeVent controls all the vents in the room, making it a centralized control.

SYSTEM DESIGN

A system is “a regularly interacting or interdependent group of items forming a unified whole” (Merriam-Webster, n.d.). In the course of this elective we have looked at systems that consist of IoT devices. Frens & Overbeeke (2009) highlight that in order to design for the vision of a new connectedness between people as well as information devices and services it is necessary to take a design perspective and include user, broader physical and social context. It also means that the task of the designer is no longer to design for an object and user considering their relationship, but to consider a multitude of products and users in one system.

Frens (2017) describes four approaches to design such systems: the hybrid approach, the modular approach, the shape changing and the service approach. We have applied the modular approach to design the U-Clean and also used it to add the WeVent to the system.
Because the Uclean already makes use of a modular approach, by adding circles and stickers for new tasks, it was challenging to connect it to a second product. Nevertheless we chose to use the modular approach since we did not want to remove part of the rich interaction we had created for the Uclean device and transfer it to a screen. A shape changing approach could be considered for the design if it was to grow further and the circular form proves as impractical due to increasing size of the device, which might require to move it to a different place.
Considering the location of the device Frens & Overbeeke (2009) mention that the locus of interaction is not necessarily the place that gives an ‘output’ of the interaction, while there can also be multiple outputs in different locations. In the case of the Uclean and the WeVent the locus of interaction is very close or even direct. While the Uclean also has a second remote ‘output’ on the central display in the living room, and the connection to the subliminal reminders and praise through the mobile application.

To come back to the social context Menniken & Huang (2012) found that “homes are not considered smart if a human can outperform the system”. This was one consideration when opting for manually setting back the filler instead of having the system do so automatically on the sticker as well as actually having the students clean and not letting a robot do these tasks. Menniken (Menniken et al. 2014) also argues that people don’t want to feel lazy in their homes. Technology should require human effort as psychologically and physically challenging as possible, changing with age (Stringer et al 2006). This is why Uclean and WeVent offer rich interaction that requires physical and psychological effort on an adequate level.

SHARED SYSTEMS

A shared system is a system of different devices and or services that are used by more than one user. This means that the social context becomes even more important and to improve such designs (Bogers et al. 2018). In our design we have set a friendly student house as the context. Taking our own experience from this context into our design process has helped define the goal of the design of the Uclean: The organisation of tasks within a friendly student house. The Uclean is a shared system in itself that accommodates several users in its nature as an organizational tool. This is implemented in the design in the name tags in the middle of the stickers and the main display. A study (Niemantsverdriet et al. 2017) that was looking at lighting as a shared system was coming to the conclusion that three kinds of conflicts often arise in shared systems. These are conflicts in: preference, attitude and activity . The preference conflict is meant to be avoided in the Uclean by letting each member of the household freely choose the tasks they are taking care of, the WeVent does so even more, the vent can be operated manually and also switched of manually when it is in auto-mode. What is not considered in the WeVent is a conflict between different people in one room, e.g. one person wanting to increase ventilation while another one wants to keep it at the same level. An attitude conflict can arise with the Uclean concerning the timer, e.g. one person finds the toilet dirty after two days while another housemate thinks it is sufficient to clean the toilet once a week. This is a conflict that cannot be solved by the product, since the cleanness of the toilet is a subjective assessment by the user. On the other hand Uclean is aiming at subliminally decreasing attitude conflicts, by reminding and praising the housemates concerning the share of housework they have been doing. Activity conflicts are probably not to be expected with the system as it is trying to help organize cleaning activities. Of course these can interfere with the activities of the other housemates, but this would also be the case without the system.

GROWING SYSTEMS

Internet of Things

Artifacts throughout our life have become more connected than before. They can be in office buildings, homes and even in public places. Internet of Things (IoT) was coined by Kevin Ashton in 1999 (https://www.rfidjournal.com/articles/view?4986) as a network of connected objects which are situated in one environment (Frens et al., 2018). As we experienced during the course, designing connected products is not a straightforward task. Certain challenges lay ahead in order to create a design for the better experience of users, especially when we want to make this experience more intuitive.

Nowadays IoT system are responsive, flexible and dynamic. They adapt to the changes in their environment and collect information which could be used in future situations by the use of machine learning or other strategies. This capacity of IoT systems to "grow" (Frens and Overbeeke, 2009) and adapt to users needs to be reflected also in its interface design. The main question is how do we create an interface which is intuitive and which fits to the dynamism of IoT systems. As explained above, our team tried to tackle the challenge by designing the Uclean and WeVent systems and integrate them into one growing system.

Core and emergent functionalities

Core functionalities are ones which are connected directly to an artifact or service and allow to be controlled (Frens et al., 2018). Our design process began with establishing the core functionalities of the Uclean which were to (1) check that a task is done and (2) show who managed it. The WeVent device was designed to control manually the ventilation system in the separate room of the house. It should be noted here that by starting the design process from the clean task manager (Uclean), our further steps were defined by the premise that we have to create the second core functionality to suit the first one. In the supposable case that the process was started from designing the ventilation system, the outcomes would have been based on its initial design. Moreso since the topics of "air quality" and "communication" can be interpreted in various ways depending on the initial setup of the constraints.

The fusion of two or more core functionalities result in the appearance of emergent ones. They would not exist if not for the direct link between an object or a service and a core functionality (Frens et al., 2018). In our design we combine the task manager and ventilation system by placing them in one location and by connecting the interaction with the Uclean stickers to an automated reaction of the WeVent.This not only provides localised access to the system, but also communicates the connection possibility of the two separate systems. In our concept we include machine learning which

tracks the manual interaction and over time adapts to the preferences of the users and thus adds to the growth aspect between the two systems. The physicalized interface is the main factor which provides the communication of the interaction between the Uclean and WeVent systems.

Approaches to physicalizing the interaction

Designing interfaces for growing systems is a process during which many possibilities have to be considered. Especially when we look through the lens of rich and embodied interaction. The fundamental goals to express the growth aspect of both systems was to get across (1) what the core functionalities are; (2) how do the systems' states change through time; and (3) how can the two systems combine (Frens et al., 2018). Regarding the abstract nature of the notions of time and tasks, expressing physically the core functionalities of uClean was a difficult undertaking. A moving colored bar shows the elapse of time and color coding is used to connect each task to the corresponding sticker at an estimated location, which is based on the nature of the task. A physical break (stopper) is used as a timer to limit the colored time bar. The system can be expanded to accommodate more tasks as mode ring modules are added. Frens describes this as a modular approach to designing for growing systems (2017). Another of these approaches is the hybrid one, which uses screen-based interaction in order to physicalize experience. It was used for the design of the WeVent. The product combined a mechanism of feathers and a screen. The screen is used mostly for communicating the air quality state and can not be directly interacted with. However, the animation provides a rich expression of how the system influences it by means of modality, time, direction and location (Djajadiningrat et al., 2002). Last but not least, a shape-changing approach was used in order to create a link between the uClean and WeVent. When the WeVent is in its "open" state, the display switches and it physically accommodates for the attachment of the uClean sticker.

CONCLUSION AND DISCUSSION

The design of the UClean and WeVent system uses tangible devices to communicate (digital) data about cleaning tasks and ventilation in a friendly student house. The aim is to make abstract concepts more graspable. By physicalizing the time a task needs until it has to be done, completing a task, the cloggedness of the air, the power of a vent we hope the user will have a more meaningful interaction with the products and will consciously think about their action when performing them. In this way, we aim at making the users more responsible about not only their user behaviour when interacting with a shared system, but also their cleaning behaviour in a shared environment.

We explored the form, interaction, and function of the design, relation between form and function, and relation between interaction and function in rich interaction. Although we find it's hard to establish the relation between form and function in Uclean because of the complication of the context, we do involve it in WeVent. In this project, we design for rich interactions in a complex context, which also provides more possibilities on exploration of fields in rich interaction.

When it comes to designing function, the highest challenged we encountered was making the translation from system parameters to parameters of use meaningful, mostly in the case of the Uclean. The reason for this was mostly because the functionalities of this product are abstract and do not represent quantifiable values (as, for example, in the case of the WeVent where power of ventilation can clearly be visually represented through the controls). However, as mentioned in the section "Design function", most of the system parameters are the same as the parameters for use. The reason for this is that our product touches on the ethical cleaning behavior in a student house, therefore, the users need to be in control of most of the functions in order to consciously acknowledge when they are hardworking and when they are slacking behind. The system parameter of vent power in WeVent was way easier to map to the parameter of use because of the nature of the functionality and the resemblance of the control with a classical design – the lamellar vent. The automated system parameters (adding points, sending notifications) are present in the Uclean in order to achieve its main goal of making people more responsible. The emergent functionality between the two is also automated to make sure the airing is properly done according to the exact measurements of the system, bringing a small part of the convenience Weiser (Weiser, M., 1991) talks about.

Frens and Overbeeke (Frens, J. and Overbeeke, C.J., 2009) emphasize the importance of controls in interactive systems. In each of our products, as well as the whole system, there is no clear distinction between centralized and distributed controls. They all present a combination that best suits the context of each functionality: executing initial settings for uClean

is preferred through centralized controls in order to avoid system errors, while indicating a task is completed is better designed as distributed to make it more comfortable for the user. Controlling the vent power at the room level is centralized since having different levels of air quality in the same room is impossible, however, controlling the vent power in the whole house is distributed since a uniform ventilation power in the whole house would not result in the same overall air quality because of the different sizes and compositions of each room.

For the design of the system we made use of the modular approach (Frens 2017) which was problematic to apply on an already modular product. If the system would grow further and require a connection of a physical device to the central display this would result in a challenge as the outer side of the rings is intended to be used for adding another task module. Unless the modularity of the number of tasks is limited this surface cannot be occupied by a different device.

Designing for growth is not an impossible task. However, the abstractness of the concepts influences the clarity of communication.

The design of the UClean and WeVent system is built on the assumption of a friendly student house and responsible housemates, since it is incessant to consider the social context of the system (Frens & Overbeeke 2009) it would be a good idea to test the design in this concept and make use of behavioural data as suggested by Bogers et al. (2018).

The system of WeVent and UClean is giving its users very little restrictions on how and when to perform tasks or adjust settings, the data collection from a test could also provide insight on whether it has the expected influence on possible conflicts (Niemantsverdriet et al. 2017).

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REFLECTION WILLEMIJN

Since I'm in the 'Design Leadership and Entrepreneurship' track I decided to do this elective because I wanted to step out of my comfort zone. It has been a while since I had done something with physical interaction so I figured I'd take a refresher on that. Doing this course made me remember why I don't do that much with physical interaction in the first place. While I do get the beauty of physical interaction, practicality and convenience will always be my main priority as a strategic designer. That made it really hard for me to stick with the assignment of the course, because I felt it was not an optimal design. To me it was forced.

The literature that was discussed in class was interesting at the beginning, but eventually became more or less the same. As well as pretty evident and non-controversial, which made it hard to start a discussion. I liked reading about 'rich interaction' as opposed to just 'physical interaction', and the relations between form, interaction and meaning. As well as (perceived) affordances. These are aspects of interaction design that are, in my opinion, quite simple but easily taken for granted. Therefore it was good to dwell on it a bit, as it did serve as an eye opener. However, in hindsight I think I was hoping to learn more about the underlying reasoning on why rich interaction should be used, instead of screen-based interaction. We did discuss it for a bit during class, but the results did not really convince me personally.

The team dynamic within our group was quite well. We discussed heavily but eventually were able to compromise and settle on concepts and ideas that everyone was comfortable with. I do feel that because of the excessive amount of work that had to be done each week on top of developing the IoT concept, the latter did not receive as much attention as I would have liked. Quite often decisions were rushed, even though we were aware of the fact that it was suboptimal, just because of time restraints.

In the end, I have mixed-feelings about this elective. When I see a good example of rich interaction I can appreciate the beauty of it, however I also think that much of the time trying to force in rich interaction can go at the cost of functionality and efficiency. The latter is very clear in our own design. When it comes to emergent functionalities they sometimes make sense, but when they are forced they feel like 'Frankenstein's design'.

I am currently focussing on designing for esports, which is pretty much entirely screen based. Combined with the fact that I am not completely convinced of the superiority of rich interaction over screen based interaction I don't think that I will be using the knowledge that I gained in this elective anytime soon, unfortunately.

REFLECTION IRINA BIANCA

I come from a Computer Science background, this being my second year in Industrial Design. Therefore, my aim, more or less with all my electives, was to explore the "unknown" (to me) and absorb all the non-mathematical knowledge that I was not used to.

I have to say I took courses in designing digital user interfaces before but nothing compares to the design of physical interfaces. I very much enjoyed this elective including the content and the layout of the classes. I mostly appreciated that, even though the principles of rich interaction are quite clear, they are not set in stone and they can be "molded" according to the context the product is placed in. I believe that even though this ambiguity sometimes gave us a hard time in designing our product, it also offered a lot of space to think outside the box and debate with my colleagues about why certain things "feel right" and certain things don't. I like open discussions and I believe that this course offered plenty of space for this as it shows that there is a very blurry line between "right" and "wrong". On the other hand, I do have a feeling that this aspect of the course was contradicting with the fact that we had to deliver designs that were "on point". This blurriness created a conflict between "we should go for this because we feel like this is rich interaction" versus "but is it rich enough for the rest to perceive it as rich?". I liked the challenges it posed but I have to say it was frustrating sometimes to position oneself as a designer in the center of the triangle: intuition, theory and feedback.

Regarding the IOT aspect of the course, the theory was way more clear in this area. Even though I did not consider designing for growing systems (before this course), I do understand that our world is headed that direction already and I did find interesting the ways in which a rich system can grow (hybrid, modular, shape changing and service). This bit of theory came at the right time for me as for my FMP I will be designing a gamified experience which uses the cultural differences between the expats and the Dutch to fuse a conversation between the two communities. The experience has to be understandable for all age ranges and has to be able to grow after the end of the project so a hybrid approach would be great for my design.

To conclude, I feel like the teamwork in this elective has been very balanced, with every member, including me, participating equally in both the ideation and realization stages. Overall, I did enjoy this course because it provided food for thought and it was challenging, though quite frustrating at times. However, "if you're not prepared to be wrong, you'll never come up with anything original." (K. Robinson).

REFLECTION LIQUN ZHOU

Rich Interaction

In this elective course, we mainly designed our product through learning the Rich and Embodied interaction, exploring and reflecting in several iterations of design, discussion, analysis, and redesign. In the beginning of the project (assignment 2), we found it's difficult to design rich interaction in a complex context. For reasons, on the one hand, we need to define the functions reasonably according to the topic (communication). On the other hand, we need to concern how to make the interaction and the form rich to the function. In this stage, we haven't defined the functions clearly, which makes it difficult to establish relation between form, interaction, and function. Afterward, with the discussion in class and learning from the papers, we concerned the topic comprehensively and defined the function clearly. For example, how the device connects to tasks and conveys time to users. In addition, although we feel hard to design rich interaction in a complex context, it also provides more opportunities in designing for rich interaction. For instance, in the beginning, we couldn't find a good way to show who did the tasks and how to show the cleaning time for the tasks in 'rich' interaction. However, with the deep understand of the concept and the context, we see many possibilities of rich interaction hidden behind.

Teamwork and Discussion in Class

That makes the development of the project smoother and meaningful is the teamwork and discussion on others' work in the class. As we were designing for a 'growing' system, the different perspectives can help us concern more comprehensive and make the concept more 'rich'. From the questions from professor and classmates, we fixed the problem regarding connections between form and function and the way to rich design the WeVent part. In addition to the discussion on our design, discussing on others' designs plays a crucial role in developing professional skills of rich interaction design. I found there are many good design and explorations in the different fields of rich interaction. For instance, the design of alarm clock is a good example in exploring the possibilities of tangible interaction and rich interaction.

In conclusion, the experience of rich interaction design improves my professional skills and helps me to reach my goal in my personal development plan. My vision is becoming a design researcher in the field of healthcare, who focuses on designing interactive technologies that can be integrated into health-related practices in daily life. With the practice in rich interaction, it helps me become more professional in interaction design and outstanding in designers.

REFLECTION FRIEDERIKE

Difficulty to achieve richness in the interaction and even more to achieve richness in interaction when designing products for a growing system.

I am not sure we accomplished to design a system that is open for eternal growth, but then again there can be growth within a specific frame. In our case the Uclean already has a physical limitation on growth, since the number of circles that can be added is limited.

This is also caused by the fact that the concept we have developed so far shows the systemic character by physically connecting the devices to show an underlying connection in their functionality. When adding other products to the system such as e.g. controls for music with an emerging functionality of having music play automatically while cleaning. It might be helpful to design a different way of showing the connectedness of the products that are part of the system.

When I would have to start over with this course I would not start with a modular product, as this made it a lot more challenging to design a system. I also found it difficult to make a meaningful connection between two products, sure there are possibilities to connect any two products to make a system, but does it really make a lot of sense to e.g. connect the light to the ventilation in a room? Or connecting a vacuum cleaner with a device showing the weather forecast for the next day? Of course there can mostly be made some kind of connection, but whether it is relevant or even helpful is a different question.
After taking this course I am now aware of the difficulties of designing for systems, while on the other hand I am not yet convinced that we need to adapt all kinds of products in a systemic way. Therefore I would not apply any approach of designing a product to fit for a system unless I see that there could be a clear advantage of connecting it to different devices or services and thereby create an emerging functionality.

In my experience we have divided tasks in the group equally and have all been involved in concept development, including the implementation of the theories from the assigned literature and lectures, as well as prototyping and documentation. Still the process has been frustrating at times and led to a lot of confusion which I believe we were able to solve for our final design. I also have realized that communicating about the design in the group was a lot easier when we had made physical prototypes. On the other hand I believe that lower quality prototypes would have been sufficient and would have allowed for more exploration and ideas.

Overall I believe that this course can contribute to my FMP which is making use of interactive materials in the automotive context, which of course need to work within the system of the vehicle and possibly also connect to external technologies.

REFLECTION GALINA

During the course of the “Designerly Perspective on IoT” many topics connected to interaction design of systems were elaborated on. The main challenge which I see here is the one of designing for change (for growth) in an intuitive way. The growing systems approach proved to be (once again) a very subjective task. The hardest part was defining the values of the functionalities and giving them an objective and physical parameter. Not only in our team discussions, but also during group ones, the meaningfulness of physicalizing abstract notions like time and quality was debated. For some it made more sense and was more intuitive than for others. The most fruitful development became evident when there were actual design examples to debate over. The context was one of the most important factors which defined how the design would be adopted in terms of rich interaction. As a team, we noticed that developing the limitations of the environment for which we worked, helped us in making concrete decisions.

An issue I found interesting was the one of overcrowding the design. We had some initial ideas (not presented) which were based on complex mechanisms, but despite their richness of action possibilities, most were labeled as confusing and too complicated. The process of simplifying the design was one that, in my opinion, gave true rich and embodied interaction. Shedding the unnecessary parts to the core elements which we needed resembles much the process of defining the core functionalities of the product. The emergent functionality between the two devices was handled in quite a different process. Once we had the core functionalities of uClean and WeVent, it was more or less clear what the emergent one would be.

During the elective I was mostly involved with the design of the forms and how can they accommodate the functionalities which were decided previously. The implementation of the theory would not have been possible without the examples in the papers and the discussions sessions. With the designs of other teams we could see how they handle the balance between designing for cognitive, sensorimotor and emotional skills. In any case, this course gave me another perspective on the possibilities of design. People who work on generating effective products can get caught up in the world of touchscreens and other multifunctional devices, but I see rich and embodied interaction as a step in the right direction towards better outcomes in the long run.