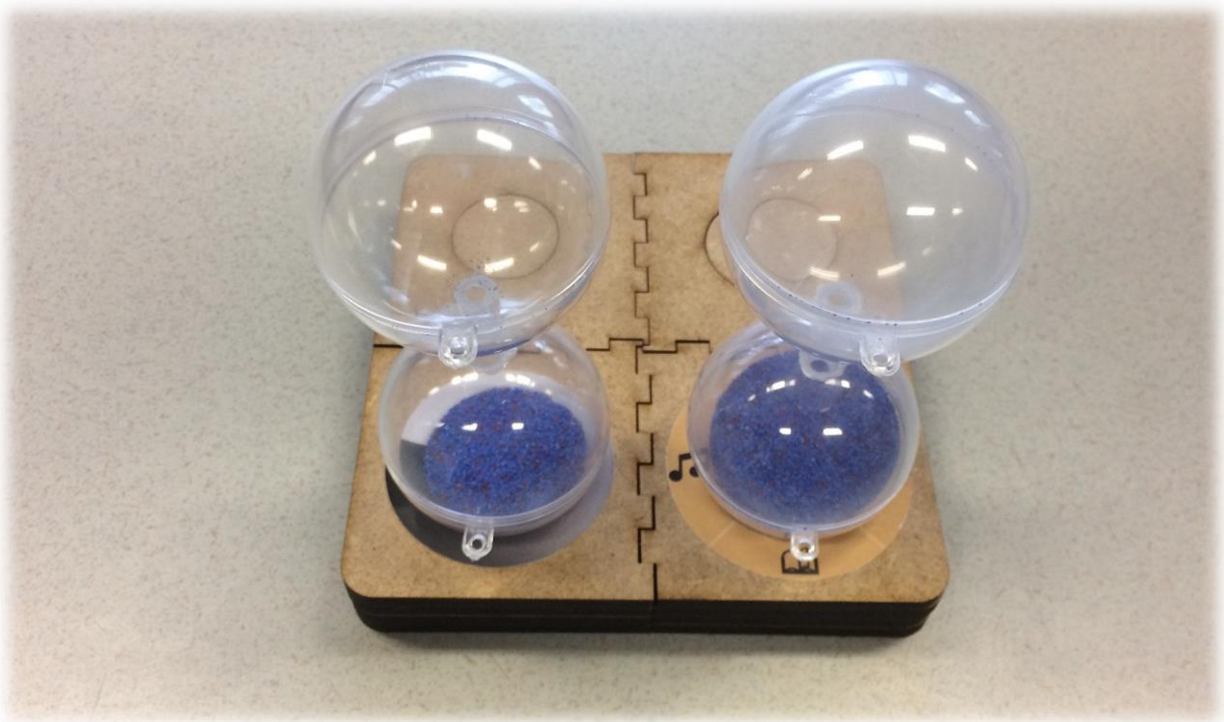
Time-Lights Design Report

A design for Philips Hue on focused and peripheral interaction



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1. The center and periphery of attention

Attention theory describes the terms 'Center of attention' and 'Periphery of attention' (Bakker et al, 2010) in multiple contexts. Center of attention can be defined as any task that most attention resources are allocated to and any other task performed simultaneously comes under periphery of attention (Bakker et al, 2010, pp. 77-78). But, in some possible scenarios, a task that a user is performing can shift between center and periphery of attention. This shifting if imparted to technology, can be termed as *calm technology* (Weiser & Brown, 1997). The shifting indicated by calm technology is influenced by *priming*, *saliency* and *user's intentions* (Bakker et al, 2010, pp. 76-77) and can be described by attenuation theory (Treisman, 1964). Any task which is governed by saliency or priming may come to center of attention from periphery of attention when a scenario triggers the same. One might want to shift one's attention resource from periphery of attention to center of attention or vice versa according to one's own intentions. Also, *level of arousal* (Bakker et al, 2010, pp. 76-77) governing the state of mind of the user, is considered to influence the shift from periphery of attention to center of attention. An important point to note is that a *controlled process* (Bakker et al, 2010, p. 75) such as reading a book requires more attention resources (in center of attention) than an *automatic process* (Bakker et al, 2010, p. 75) such as walking (in periphery of attention). Thus, the level of arousal is more for controlled process than automatic process (Bakker et al, 2010). A controlled process can be made automatic by imparting automation to the task or getting trained to use that particular process. Thus, by this way we could shift from center of attention to periphery of attention.

Divided attention (Bakker et al, 2010, p. 75) is a process which explains the basic procedure of any task becoming center or periphery of attention. The attention resources are limited in nature and are allocated optimally by the *attentional supervisory system* (Salvucci et al, 2008). The process of division of attention or mental resources can be further explained by *threaded cognition* (Salvucci et al, 2008, pp. 101-103) which encompasses a central procedural resource coordinating the execution of multiple threads. A task having a single thread and in case of multitasking, multiple threads can make use of various 'peripheral resources,' such as visual resources, motor resources or memory resources (Salvucci et al, 2008). The extent to which two activities can be performed in parallel depends on their stage of execution and the particular resources they require (Bakker et al, 2014). Also, *multiple resource theory* (Wickens, 2008) well explains the division of mental resources optimally among different modalities and stages of perception, cognition and response. Thus, understanding the way divided attention occurs, one can come to know what could be in the center and periphery of attention.

2. Video Analysis

People develop routines which can often be performed in parallel in their daily activities. "In some situations, multitasking can seem nearly effortless (e.g., walking and talking); for other situations, it can seem extremely difficult if not impossible (e.g., reading and listening to two distinct sentences)" (Taatgen & Salvucci, 2008). The following examples show people performing their everyday activities. It becomes clear what causes an activity to be performed in the periphery or center of attention.

1) Change gas

Attention: Divided - Center of attention, gas dial. Periphery of attention, phone and pan on fire.

Cause: The pan on the fire requires attention, while using the phone. Phone is on hold, while attention shifts to gas dial. The shift is caused by priming and saliency. The auditory feedback from boiling water is a familiar sound that draws attention.

Fig.2.1 Screenshot for changing gas

2) Laundry

Attention: Divided - Center of attention, find spot for hanging cloth. Periphery of attention, grab laundry hooks.

Cause: Switching activity. Already looking ahead. Different modalities are used. The laundry rack is using most of the visual resources, meanwhile most manual-spatial response resources are used for grabbing laundry hooks.

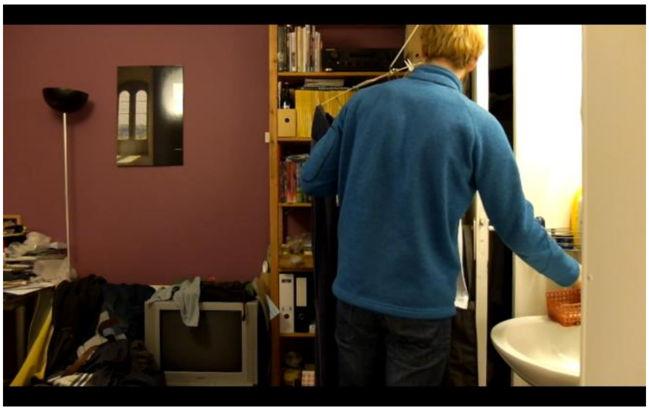

Fig.2.2 Screenshot for laundry

3) Cleaning spoon

Attention: Divided - Center of attention, spoon. Periphery of attention, water tap.

Cause: Already looking ahead. Visual resources are mostly on the spoon, which is in the center of visual field. Some visual resources are used for the water tap, which is in the periphery of visual field. Auditory resources are also used to hear the noise of the water flowing. Since, two different modalities are used in the periphery, multitasking is done efficiently.

Fig.2.3 Screenshot for cleaning spoon

4) Use mouse

Attention: Divided - Center of attention, reading. Periphery of attention, mouse, listening music.
Cause: The attention shifts between reading and scrolling with the mouse. Since, two different modalities are used in the periphery, multitasking (visual for reading, manual-spatial response for using mouse and auditory for listening to music) is done efficiently.

Fig.2.4 Screenshot for using mouse

5) Turn on vacuum cleaner

Attention: Divided - Center of attention, turn on vacuum. Periphery of attention, holding vacuum.
Cause: The on button of the vacuum cleaner is in the center of visual field. Multiple modalities are used. Visual for locating button, manual-spatial response for holding the cleaner and pressing the button.

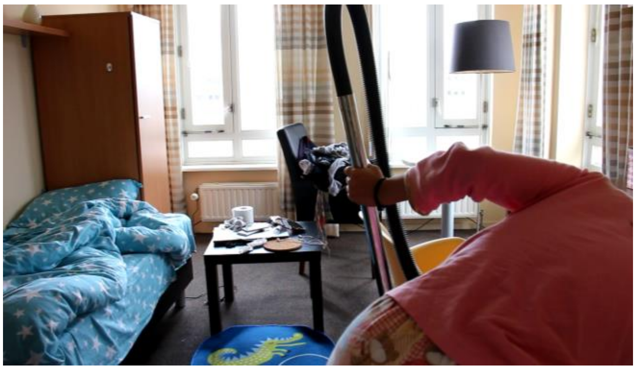

Fig.2.5 Screenshot for turning on vacuum

6) Hold carpet

Attention: Divided - Center of attention, vacuum. Periphery of attention, holding carpet.
Cause: Most resources are needed for the main task, vacuum cleaning. The cleaning is in the center of visual field.

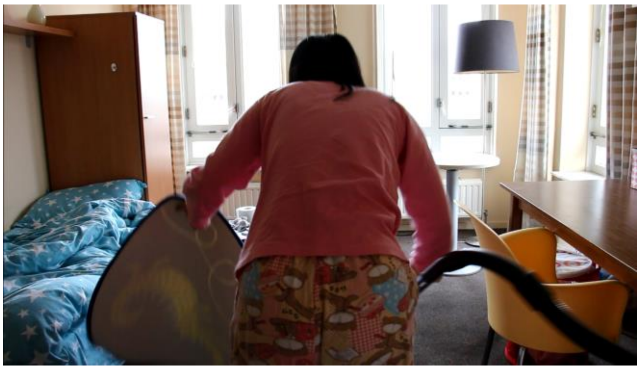

Fig.2.6 Screenshot for holding carpet

Conclusion

Many activities are performed in the periphery of attention, because of activity switching. These attention switches are mostly caused by the users' intention or priming and saliency. When the focus of attention shifts to another activity before the current activity is finished, consequently the current activity often becomes the activity in the periphery of attention. Other peripheral activities are caused by the limitation of the center of visual field. Activities that happen outside the center of visual field are often in the periphery of attention.

3. Examples of existing interaction designs

A. Miglani

The first example is of **Navigation system** used while driving from one point to another. This system could be used in our *center of attention* or our *periphery of attention* (Bakker et al, 2010). While driving, our center of attention i.e focused attention (Bakker et al, 2010) is primarily on the road i.e. we use our visual modality towards looking at the road. However, if the driver wants to check the route he/she can do so, by looking at the navigation system and thus, the center of attention at that moment is towards the navigation system. Here, divided attention of the driver could take place if he/she is using his/her visual modality towards looking at the road while driving simultaneously with checking the route from navigation system. This could create high mental workload on the driver. Designers have tried to lower the mental workload of the driver by using voice control navigation. By this mode of the navigation system, driver can 'focus' towards the road (using his/her visual modality) and simultaneously use the navigation system in the periphery (using auditory modality). According to multiple resource theory (Wickens, 2008), multitasking is achieved optimally by using different modalities. To conclude, we could use the navigation system in the center of attention (directly checking the route by seeing) as well as the periphery of attention (using voice control mode of the system). Thus, *calm technology* (Weiser & Brown, 1997) is achieved by the system and depending upon the driver's choice, attention could be switched between focused and periphery.

The second example used in our daily life is of the **residential heating system**. This system could utilize focused interaction or peripheral interaction or implicit interaction (Bakker et al, 2010). We could set the temperature of the heating system manually by adjusting the temperature knob, thus interacting with the system directly. Another option given to the user is to set the temperature through remote-control. However, the user does not have to interact with the system directly but a third-party control (Remote control). Point to be noted is that in both of the modes described above, the user has to focus attention towards adjusting the temperature (be it remote control or directly adjusting knob). But, once the user becomes habitual of the control, he/she can adjust the temperature by not focusing towards the system and thus, involving his/her peripheral attention (Bakker et al, 2010). The heating system also has an automatic mode which senses a pre-defined temperature threshold, below which the system turns on. This mode would not require interaction by the user. Thus, this automatic mode involves implicit interaction (Bakker et al, 2010). However, defining of the temperature threshold for the first time would involve focused attention of the user. Therefore, the interaction for this system could be focused or peripheral or implicit interaction (Bakker et al, 2010).

Q.Qi

CHOCO is a product combined with light and Bluetooth speaker. Users can connect CHOCO to their smart phones playing music by Bluetooth. Light above changes automatically according to rhythm of music, which is implicit interaction. It is presumptuous and automation in the background (Wendy & Larry, 2008). Another interaction for accepting or declining call depends on occasions. When the user is too busy to accept the call, he or she would put the speaker down casually. In this situation, it is peripheral interaction. The whole interaction can be explained by Norman’s action cycle. The interaction starts when one person hears the bell ringing. The perception, interpretation and evaluation of light color occurs in the periphery of attention. After that, the goal is to decline the call, which is in the center of attention. And then, the person puts the speaker down. Those sequence of actions and executions are in the periphery of attention. We can see from the interaction that it illustrates the important character of peripheral interaction, which is that it can shift between center and periphery of attention (Bakker et al, 2014). However, when the bell rings the users are not that busy. They may want to know who is calling and decide to accept or not so the whole interaction becomes focused.

Muji CD player is a wall-mounted CD player. Once you pull the cord, the motors start to turn and you hear the sound. When you pull the string again the sound and the motors stop. It is a typical peripheral interaction. Many interactive systems may benefit from peripheral interaction (Bakker et al, 2014). For some systems, it seems desirable that they shift to the periphery of attention so the player make use of that. And the gesture to pull the string is often used to turn on or off the lights so most people don’t need to learn. Moreover, it is simple to use one movement to control the opposite interactions while you can feel it without paying attention on purpose. Now, the CD player is developed to add remote control to choose favorite songs and change the volume. The interaction using remote control between the CD player and person in the new generation is focused interaction because the users have to pay most of attention to manipulate different functions of the player.

B.Rutten

Cruise control

When engaging or disengaging the cruise control the center of attention is on the interaction with the system. Whether it is pushing a button on the steering wheel or pressing the pedal, the attention is focused.

However when we cruise along, the interaction with the system moves to the periphery of attention. We can focus on other tasks such as steering and processing traffic, but there is awareness of the cruise control system. It will never completely disappear from the drivers mind and is thus in the periphery of attention.

Advanced cruise control systems are situation aware. They monitor the traffic in front and respond to it by adjusting the speed of the vehicle. The user is not involved in this process. The interaction is implicit.

OV-chip check-in/out terminal

Depending on his mood, the traveler is pays attention in different ways. A traveler in a hurry might swipe his OV-card over the terminal without focusing attention on the visual information, but in the periphery of his attention he is still aware of the auditory confirmation produced by the terminal.

The same traveler might focus his attention on the display when he is checking out to see the amount of credit on his card.

4. Description of and motivation for Final design

Our **context** is based on people who are working at home. In the context, work is main stream but leisure is also a part of it. Considering the relationship between target group and environment with time passing by, we design scenarios as Fig.4.1. To utilize the features offered by Philips Hue, we choose to control three variations of lights - on/off, brightness and different modes.

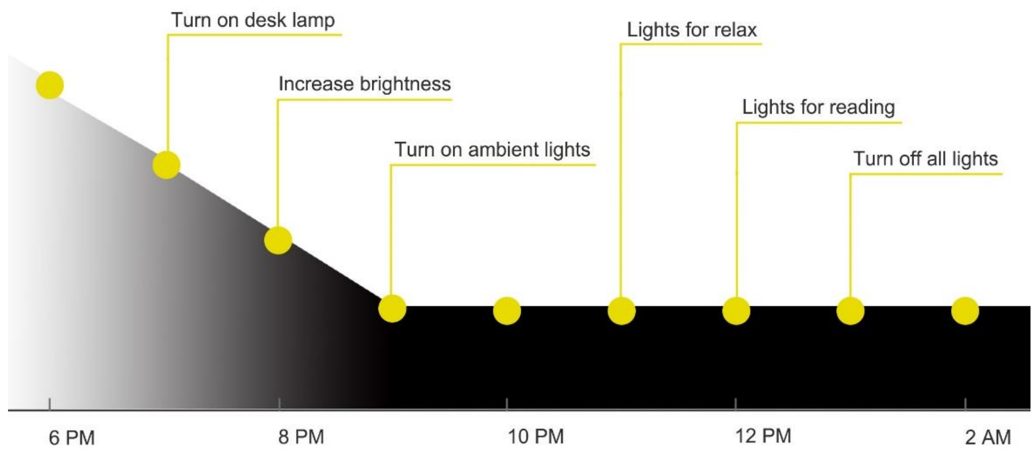

Fig.4.1. Scenarios for design

Our **design** is developed based on attention theories that can be explained in materials of resources shown in Fig.4.2. Prototypes for first iteration and second iteration are shown in Fig.4.3 and Fig.4.4. Based on the feedback from lecture and clients, we improved our design and made another iteration which is also the final design for controlling Philips Hue. In our final design, sand glasses are chosen as controllers. Sand-hour glasses are well coordinated with time part of context. We continue to use timer for our design to make it more playful. The mode or brightness changes to your previous setting after sand all flows down, so as to enhance the productivity of the users' work at home. Moreover, the sound of sand flowing gives the user an auditory feedback in his/her periphery about the time passing by. As *multiple resource theory* (Wickens, 2008) explains the division of mental resources optimally among different modalities and stages of perception, cognition and response, the user is able to multitask efficiently. This can also be explained further according to the example in section of video analysis, in which the person is focused on the laptop, at the same time, listening to music and clicking mouse. In our design, two controllers are necessary due to the leisure part and work part. One is mainly for desk lamp and the other one is for other lights of the room so as to create the ambient atmosphere for users. The design for controllers which can be used both together and separately is also a modular design. This means not only one user but also multiple users can use the controller for ambient lights in any part area of the room so as not to distract working people. The controller for desk lamp can change the brightness. During work, brightness is an important factor that contribute to users' work. So, we decided to use rotating as gesture for controlling brightness of desk lamp. The clockwise is for increasing the brightness analogous to increasing the volume. The controller for ambient lights, more focused on leisure, has four modes including working with laptop, reading, coffee and music. Moreover, we chose putting down and up for lights on/off because it is simple to learn and easy to transfer to peripheral interaction. All interactions in our design are shown in Fig.4.5.

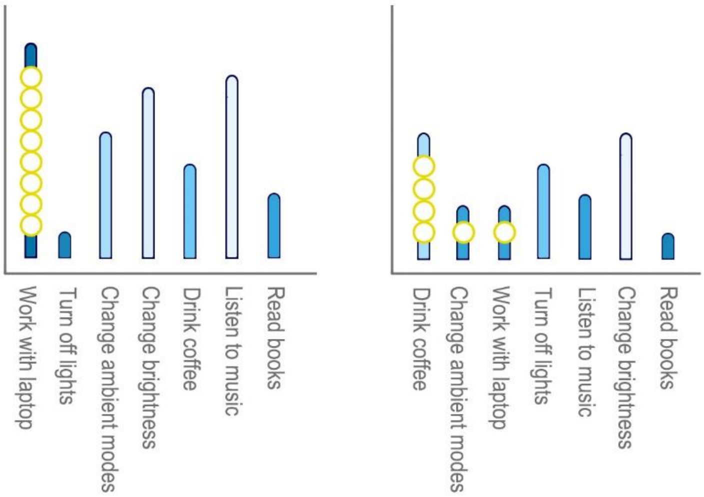

Fig.4.2. Division of resources of attention in some scenarios

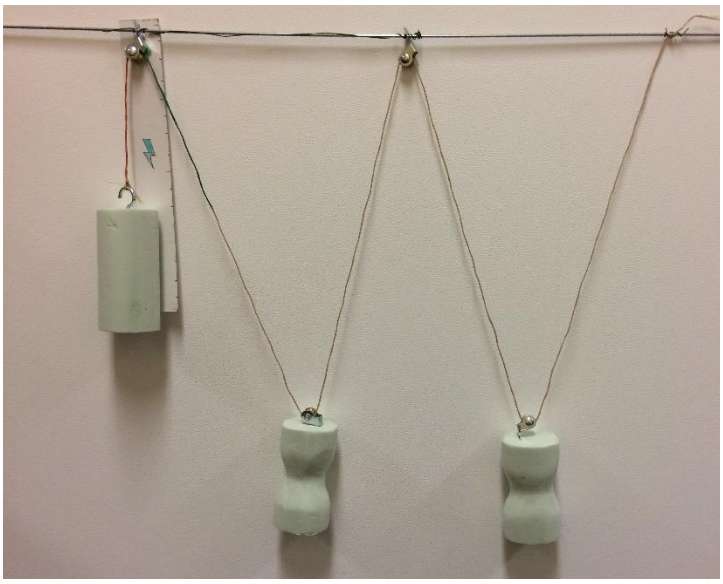

Fig.4.3. First iteration of design

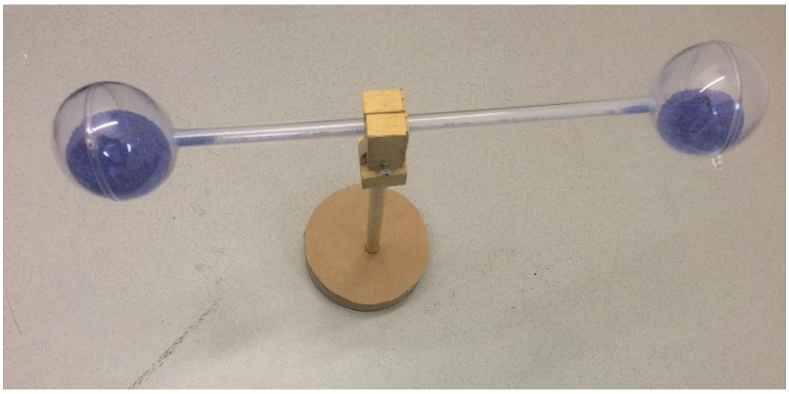

Fig.4.4. Second iteration of design

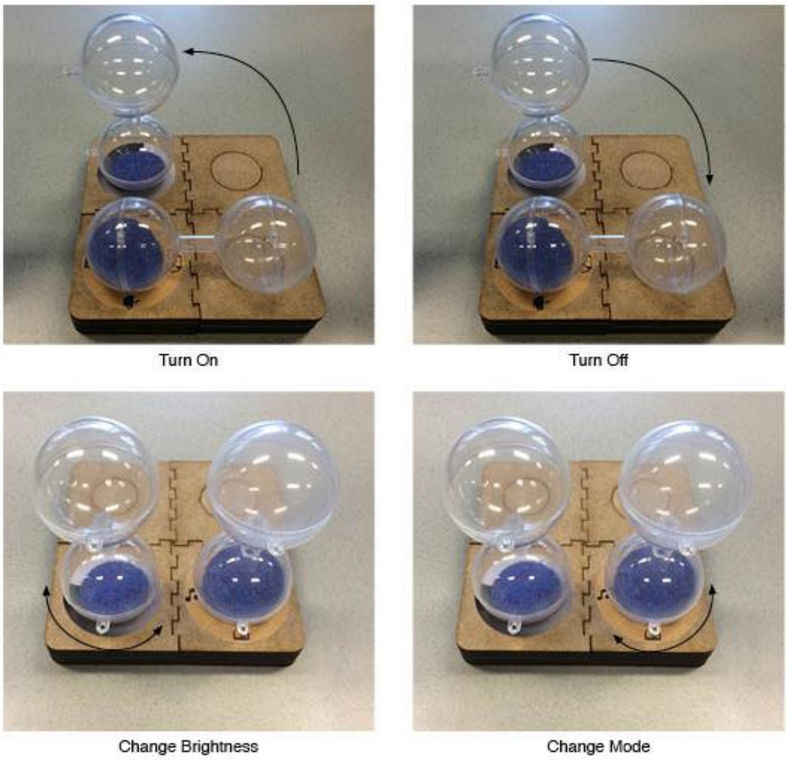

Fig.4.5. Interactions of design

User evaluation is conducted with six participants who interact with prototype in the context of working environment in Breakout room. The aim of the user evaluation is to prove some interactions are peripheral interactions and obtain input for developing our design further. The process of the user evaluation is divided into three sessions. The first session is to introduce how design works. In the second session participants are asked to complete 5 specific interaction exercises, (1) turning on the desk lamp, (2) increasing the brightness of desk lamp, (3) turning on the other lights in the room, (4) setting a timer for the ambient lights into coffee mode, (5) turning all the lights off in the room. The third session is for gathering data including filling out the Rating Scale Mental Effort (RSME) for each interaction exercise and making a stimulated recall interview referring to the video of participants' behavior in second session. By three sessions, we collected quantitative and qualitative data on our design.

The **results** of RSME are shown in Fig.4.6.We can see that score on the fifth interaction is lowest which is a little bit lower than the first interaction. Actually, those two interactions are similar and just reversed actions. Thus, it is obvious that resources of attention can decrease along the increasing times of practice. Since those two scores are low and many participants also mentioned that they do not need their focus when those two interactions in the interviews, they can be proved as peripheral interactions. The fourth interaction has the highest score due to the attention to different modes so this is focused interaction in our design. Also, pointers are small and not clear leading to more attention on the fourth interaction according to some participants' insights. Throughout the interviews, we also got some insights on our design. Many participants thought that the prototype is not stable and this may influence their ease of use. Based on the feedback received from the users, we improved our design further and it is shown in Fig.4.7.

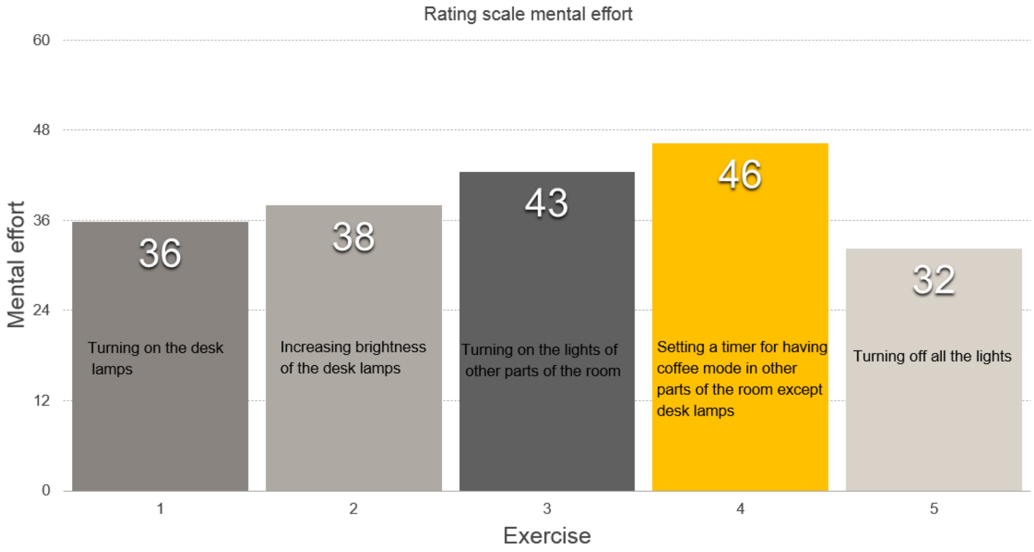

Fig.4.6. Results of Rating Scale Mental Effort

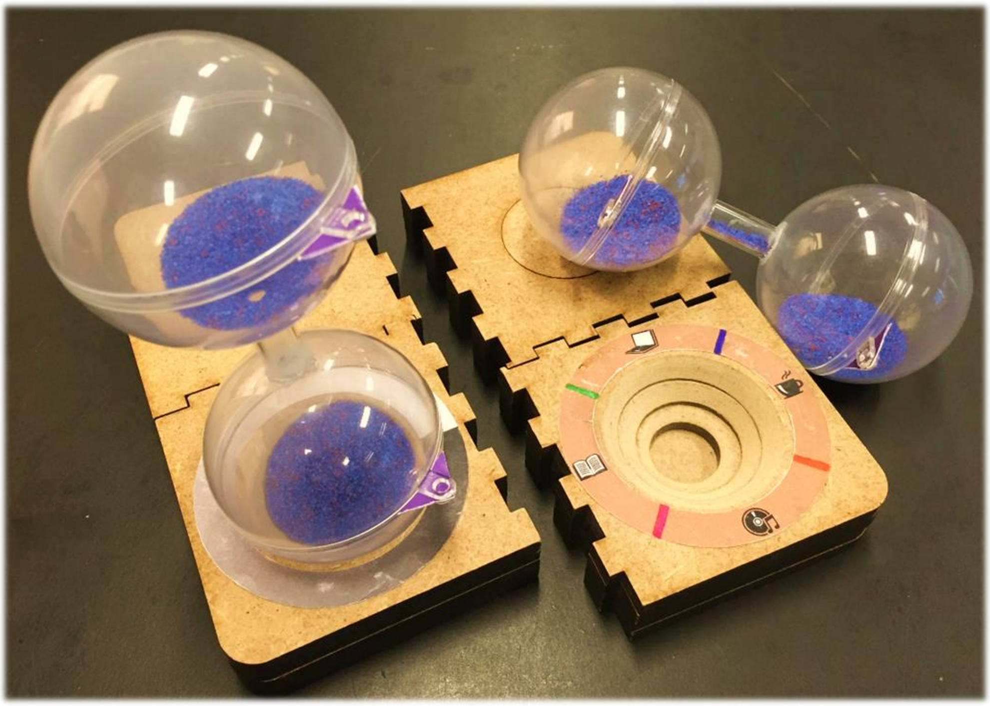

Fig.4.7. Improvement on design

5. Discussion of final design

A. Miglani

Depending on the task performed/feature used of the prototype, two interaction styles of the interaction-attention continuum is utilized– Focused and Peripheral interaction (Bakker et al, 2010). Our prototype is for people working at home (primarily on working desk). The features offered by our prototype are: (1) Turning on/off the desk lamps or lights of other parts of the room, (2) brightness adjusting for desk lamps, (3) setting timer for having different modes/emotions (combinations of different hue/saturation/brightness) of all lights of the room except the desk lamps, (4) setting timer for having desk lights analogous to relaxed atmosphere. The main motive behind adding timer as a feature was to enhance or at least maintain the productivity level of the user who is working at home. After various design iterations of our prototype, user testing was done – both quantitative and qualitative. The users were asked to enact certain tasks while using some of the features offered by our prototype. The results for the quantitative test and the tasks performed are shown in Fig.4.6.

The users were asked to use the prototype in their periphery while either working on the laptop or reading a notebook. After the test, some comments were made by the users. According to all users, task-1 and task-5 were the easiest among all the tasks that were performed by them and they were confident that they will be able to perform these two tasks in their periphery (Bakker et al, 2010). The users also stated that as turning on and off involved almost the same motion for using the prototype, they were used to this motion by the time they were asked to perform task-5. This is the reason why the users gave less mental effort rating for task-5 compared to task-1. Also, this justifies that indeed, users will be able to use the prototype in their periphery of attention. The only improvement suggested by the user to efficiently use the prototype for task-1 and task-5 was improving the shape of the prototype and make it more stable. After the improvement, the mental effort should have reduced.

For task-2, some users looked at the prototype to see which way to turn it to increase the brightness of the desk lamps. So, it distracted them from the primary task (reading from the laptop). Task-2 thus involved focused attention (Bakker et al, 2010) of the user. However, when the users were asked about the possibility to turn it to their peripheral attention (once they are habitual of using the prototype) (Bakker et al, 2010), they said they will be able to use the prototype for performing task-2 in their periphery (Bakker et al, 2010). Other users were able to use the prototype for performing task-2 fluently in their periphery. After asking them about it, they said that the motion was organic and natural to them. For increasing the brightness, clockwise direction should be made. The users should have been familiar with this analogy as this is a basic principle which is used in our everyday lives i.e. if we want to increase some quantity, turn it clockwise. So, task-2 involved peripheral attention for some users and focused attention for some. However, once user becomes habitual of using the prototype, focused attention can become peripheral attention of the user.

Task-3 involved the same motion as task-1 and task-5. However, the users were confused about the motion in this task which they stated happened because of two controllers being used i.e. one for controlling the desk lamps and the other for controlling the lights of other parts of the room. They said that they had to focus on searching the second controller and could not perform the task in their periphery while doing the primary task. But, when the users were asked about the possibility to turn it to their peripheral attention (once they are habitual of using the prototype), they said they will be able to do so. So, task-3 involved focuses attention for users. However, once user becomes habitual of using the prototype, focused attention can become peripheral attention of the user.

The most tedious task to perform for the users was task-4. The users said they had to explicitly look at the prototype to check the location of different modes and then set the timer accordingly. This task distracted the users from doing the primary task and it involved focused attention by the user on the prototype. Being asked the possibility of doing the task in their periphery if some feedback is provided for all different modes, the users said they might be able to.

To conclude, the prototype did involve focused attention for some tasks and peripheral attention for other tasks. However, after some improvements and once the users become habitual of using the prototype, all the interactions could become peripheral interactions (Bakker et al, 2010) and users could be able to interact with the prototype in their periphery.

Q.Qi

Our design is in the context of people working at home. Activities for our target group are not too much. Those activities can be divided into work part and leisure part. Based on this, we design two sandglass controllers for lights, one for desk lamp contributing to work and the other for ambient lights focus on leisure. During work time, laptop is always in center of attention. In order to not divide too much attention from their work, the interactions between users and controllers should be peripheral. However, in the leisure time, the users do not need totally focus on specific things so focused interactions can be designed in this situation. Therefore, parameter for desk lamp is brightness that is increased in rotating clockwise and parameter for ambient lights is different modes, icons for which are shown on the holder for sandglasses. Clockwise rotating for increase is a common design in our daily life and this can be easily transferred to peripheral interaction. But changing modes may require users' attention because of the icons so adding something interesting for their attention is necessary. Since sandglass already has a playful interaction, sand flowing for timer, just use it in our design as rewards for focus. Both of the controllers have the same interactions for turning on and off, which are putting down and up. The gesture is easy and somewhat similar to normal switch for the lights. In my view, any interactions for lights on and off cannot be allocated less attention than the normal switch, so the design we can do is to make them reversed and simple actions.

In user evaluation, we asked participants to do 5 specific interaction exercises with our prototype. Most of time, they did multitasks like their daily life. By observation of participants' behavior, interviews on their feedback and results of RSME, we collected both quantitative and qualitative data on our design. The average score on mental efforts of each exercise is shown in Fig.4.6. The fourth interaction gets the highest score because participants think they need to look at the holder to set mode they want. Thus, this interaction is focused during test but it can be developed into peripheral interaction over time in some participants' opinions. The first exercise and the fifth exercise are reversed actions but the fifth has a lower score than the first. It shows that resources of attention can decrease after practice even though just once. Since the scores of those two are lowest and many participants support a little effort is needed, they are peripheral interactions. For the second and third exercises, they often shift between center and periphery of attention (Bakker et al, 2014). It really depends on participants' behavior, habits and experience of their life. Sandglasses are always falling down in the test so that participants have to divide their attention to make it stable. I have to say ease of use can also contribute to periphery of attention. However, some of them think it is interesting and does not disturb them. In terms of design, feedback is gained throughout the process of evaluation. There are some conflicts on timer, some participants like the idea while others hold that they would not utilize this function in daily life. Also some participants want to know how long exactly the timer is.

Based on feedback that we receive from user evaluation, we make the prototype more stable to enhance the ease of use and design a clearer pointer for users to set modes. And the insights from lecture and clients inspire me further in future steps on design. Now, our design is just specific to four activities which means the scenarios are limited so design should be more flexible to adapt different activities to working people at home. Since the controllers are portable, they can also be developed to use in living room or kitchen. As far as I'm concerned, the timer needs to continue although some participants are doubtful about it. Design needs something fun to make it playful and timer is just it. Also, uncertain of the timer may give users space of imagination. Moreover, the interaction for time is peripheral interaction so this can be well involved in their life routine. However, how to transfer timer fit for the context of working will be a question that needs to think deeper in the future. From this course, I learnt a lot about attention theories and case studies on peripheral and focused interactions which are useful for me and can be applied in my future project.

B.Rutten

Throughout the process the prototype has been continuously improved to make a better peripheral interaction for Philips Hue. The chosen user context is working at home.

The first three prototype iterations have been developed based on theory and by acting out scenarios to see how the interaction would affect the attention of the user.

The third iteration of the prototype was used in a user test. Based on the user testing we made an improvement over the third interaction. From the data gathered with user testing, we can conclude that the prototype enables interaction within both focused- as well as peripheral attention. Some interaction exercises performed by the users proved to be easier than others.

Users commented on the instability of the prototype, resulting in complicating a simple interaction. For instance turning on the lights (exercise1), costs more mental effort then turning off the lights (exercise 5), although the interaction is quite similar. The difference in mental effort has to do with the stability. For turning on, users are carefully positioning the prototype to make sure it does not fall over. This is no issue for turning off.

After user testing the prototype the stability is improved.

Interactions that are originally performed in the focus of attention, can grow over time to be performed in the periphery of attention. For example operating a steering wheel is not a peripheral interaction when you use it for the first time, but for experienced drivers it is.

After completing the exercises of the user test, the users were interviewed about the exercises. Users were confident that, after some practicing, they would be able to operate the prototype on the side, in the periphery of their attention, while working.

The functionality of Philips Hue is endless. It is not always easy to focus on one particular functionality. Pursuing limited loss of functionality, arguably resulted in a more complicated interaction device then desired.

The clarity of the user's intentions have influence on the interaction being easy to operate in the periphery of the user's attention. A user that has a clear expectation of the desired reaction on its action will be confronted with either confirmation of the interaction or disappointment if the reaction is not as intended. A user without clearly defined expectation, may just interact with the controller and see what it does. This way the user can never be disappointed in the reaction because the intention was to get surprised. To summarize, the more opportunity for interactions with clear results, the more difficult it becomes to design for peripheral interaction.

If we apply this theory to the prototype, we could ask a user to set the light to specifically coffee mode or any mode. In case of a specific mode the user will have to think about what action to perform to get the intended result. In case of any other mode the user can just do any action that changes the mode. Interactions with less specific intentions are more likely to, result in peripheral interactions.

The user context is working at home. The functionality of the prototype is aimed to support the user with working. The most important light source for desk work is a desk lamp, but the rest of the room has also influence. The prototype is not that flexible that it is suitable for every home scenario. This is an example for a specific scenario and its functionality is dedicated to that context. I believe that it could be a role model to other home contexts. The kitchen might need different lighting functionality. There is not one perfect peripheral interaction device for every context.

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