Juggling a growing IoT system

Exploring an alternative reality to interaction within IoT with Rich and Embodied interaction

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Introduction

Our experimental design journey is focused on designing for community. More specifically, designing a modus operandi for a home IoT system (Miorandi, Sicari, De Pellegrini, & Chlamtac, 2012), revolved around a shared music experience, for instance Spotify party. Such a design is currently revolved around the use of smart phone devices, which take away tangible (Ishii & Ullmer, 1997), rich (Frens, 2006) and embodied interaction (Dourish, 2001). As discussed by Angelini, Mugellini, Khaled, and Couture (2018), a smartphone like modus operandi decreases the user experience and has the risk of alienating the user from the physical world. Not only in physical interaction but also in social interaction (Gladden, 2018). Smartphones are known to inhibit face-to-face social interaction, resulting in a less satisfactory social experience (Rotondi, Stanca, & Tomasoulo, 2017). Rotondi et al. (2017), also describes this intrusiveness as a challenge for the future interaction design of the smartphone as it becomes more and more connected and smarter.

This phenomenon is especially relevant in the context of IoT, in which smart objects play a central role. Therefore, this experimental design journey explores how to design an IoT system in the initial scope of community, additionally in the scope of lights and growing systems (Frens & Overbeeke, 2009), (Miorandi et al, 2012).

Assignment 2

For the first iteration, the smart phone device as modus operandi is replaced by an embodied IoT device formed like a ball (figure 1) that helps improve community through interactive selection of music. This design moves the rather passive socially isolating action of selecting music through a smartphone (Gladden, 2018) (Rotondi et al, 2017), to an embodied interactive device that makes influencing music proactive and collective, creating an aesthetic experience (Ross & Wensveen, 2010). The device is designed for a house party context and focuses on influencing the music through embodied interaction. When attending the party attendees can link their Spotify to the device, making their personalised playlists and data about their music preferences available for the party. Then follow multiple interactions which accommodate creating a community around the selection of music, by making most functionalities only possible when multiple people are interacting with the ball at the same time. The multiple interaction possibilities along with a technological realisation proposal, a discussion of the design limitations and what we learned about rich interaction in IoT during this assignment are presented below.

Figure 1: The first iteration: an embodied IoT device for collectively influencing music at a party.

Tempo

Throwing the ball will influence the tempo of the music (figure 2). The idea is that the ball will 'read' the mood of the crowd through the throwing behaviour of the people at the party and provide music to accompany this mood. More frequent and/or faster throwing will increase the tempo of the music, to better suit the energetic mood of the crowd. On the other hand, slower and less frequent throwing of the ball will decrease the tempo of the music, creating a more easy-going setting. Focusing on Klemmer's definition of performance, how physical interaction in deciding the mood of the music is faster than a symbolic form of communication (Klemmer, Hartmann, & Takayama, 2006). Throwing the ball also stimulates people to seek contact with each other, since another person is needed to catch the ball. This also allows for people with different needs (one that wants higher tempo vs one that wants slower tempo) to 'negotiate' the tempo of music by expressing their needs to each other through physical interaction, their throwing behaviour, which accommodates the expressive nature of the ball.

Figure 2: Demonstration of throwing the ball to increase the tempo of the music.

Throwing the ball was used as Embodied Facilitation (Hornecker, 2005) so people would come together and create a community when selecting the music: you need another person when throwing the ball. The playful aspect of throwing a ball fits very well with the context of a house party, where the expressiveness of the throwing goes well with the need to communicate a mood to a device. Throwing the ball also creates the embodied interaction with the device, which adds to the expressiveness

Selecting music

Increasing the tempo of the music to accommodate the mood is a very broad statement, since different people like different kinds of music. We therefore added the possibility of selecting a Spotify profile, to guide the ball to what kind of music should be played, and what kind should be played when the tempo should increase. On a screen in the middle of the ball a list of 'members' of the party is visible (figure 3). These members are all the people whose Spotify is currently linked to the ball. When turning the half of the ball closest to the members' names, the user can scroll

Figure 2 Demonstration of throwing the ball to increase the tempo of the music.

through the list of names. The displacement of the names is directly linked to the displacement of the turning motion. To select a user, the sphere half used to turn can be pushed down. When doing so, the Spotify lists of the selected user appear on the screen. The user can then navigate through the lists using the same turning motion and press down to select a list. Showing whose music is currently playing could also start a (playful) discussion of the quality of the music, adding to the community value.

Skipping a song

The exterior of the ball is made of a soft & stretchable material. When pulling or tugging, this material will expand and stretch. When multiple people do this together, the song playing at that time will be skipped. The control to skip a song in current devices is designed to be actionable for one person, and thus skipping a song can become an individual's intervention which can raise dissatisfaction amongst others. When users want to skip a song on the IoB multiple people are needed to pull on the ball, making it a group effort. This interaction stimulates people to get up and find like-minded individuals, and to interact with each other instead of just with the device. Thus, focusing on the third principle of IoT, connecting end-users to perform an interaction (Miorandi et al., 2012).

Volume

There is a difference in material hardness between the two halves of the ball. One half is significantly harder than the other half, which can be felt when holding the ball. Bouncing the ball on the hard side will increase the volume of the music. Correspondingly, bouncing the ball on the softer side will decrease the volume. This design is based on the bouncing affordance that a ball evokes (Gibson,1986), where we tried to focus on creating embodied interaction instead of adding functionalities in the form of simple buttons.

Technological realisation

To realise the tempo and volume control function, an accelerometer can potentially be used to assess the throwing and bouncing of the ball. At first glance, from a sensorial standpoint, those two behaviours seem very similar, but there is a slight difference that can be measured. When throwing a ball, it accelerates until it is released from the hand which throws it. When caught the ball rapidly decelerates speed to 0m/s and stays at around that level before being thrown again. On the other hand, when a ball is bounced, it accelerates downwards, hits the ground and for a brief moment, decelerates to 0m/s, before rapidly moving upwards again. It is this distinction that makes it possible to use the same sensor to measure these separate two behaviours.

To select music a simple potentiometer and press button can be incorporated into the ball. The potentiometer is connected to the sphere half, allowing the IoB to read the turning motion. Underneath the sphere half a press button is placed, giving the opportunity for the sphere half to be pressed at any orientation and to provide the haptic feeling of a press button.

To skip a song the ball needs to be pulled by multiple people. This can be done by incorporating a pressure sensor in the interior of the ball. When enough people are pulling on the exterior of the ball the exerted force can be measured, when a certain threshold is reached the song is skipped.

Discussion/limitations

The first iteration contains several limitations that need to be tackled in the following iteration. First and foremost, the feedforward regarding some of the actions is unclear ((Djajadiningrat Wensveen, Frens, Overbeeke, 2004). During the design process many interactions were designed while holding "incorporating as many people as possible into the action" as a main value. Interactions such as the throwing of the ball to increase or decrease the tempo and the pulling of the exterior to skip a song resulted from this. The pulling of the exterior could potentially be a good method for getting people to seek more contact and to collectively influence the music, however, the interaction itself does not represent the context of the action, which is skipping a song, and therefore must be learned. The same goes for controlling the volume of the music, which is adjusted by bouncing the ball. Although the soft and hard side of the ball can be sensed while holding it, which might be interpreted correctly as having to do something with the volume, there is nothing that indicates that the action of bouncing controls this function.

At last, there is a procedural element in the process of choosing the music. One can scroll through all the attendees' Spotify accounts by turning a sphere half and then select one user by pressing down on the sphere half, entering a new window and thus moving through a menu display. As discussed in the introduction, a screen like display has the risk of alienating the user from the physical world (Angelini et al, 2018). To create an interaction that connects users through the physical world, one should design without any smartphone like interfaces at all. This display-based interaction should be replaced in further iterations with something more minimalistic that does not have a procedural element.

To conclude, most of the designed interactions were created with a tunnel vision on embodiment and involving multiple people in the action, and while doing so the feedforward of interactions and several affordances where poorly executed. Many functions were linked to actions that the ball already afforded doing, instead of starting from a functionality and designing an action with the necessary affordance for it.

But how about rich and embodied IoT?

During the first assignment we were introduced to the world of IoT, and all its possibilities to be rich and embodied. When starting this course, it seemed to make sense everything was screen-based or smartphone based: you can update the interface, you can add an endless number of functionalities (Frens, 2006), and when it's smartphone based nearly everyone can connect and use the IoT device. However, this means you have to control everything via a screen, or like in our case, from a smartphone. When people are using their smartphone, or in our case: selecting music, they disappear into their phone, losing contact with the people they want to connect with when they're enjoying the party (Gladden, 2018) (Rotondi et al., 2017). We considered it nice, being able to control your own playlist like you're able to in Spotify Party and selecting every specific song you want to hear that night, but you don't want to be focussed on your phone when you want to be social.

Designing an IoT device that would be rich and embodied was difficult to imagine at first, since there are many functionalities to Spotify Party and it's hard to imagine it without them. We seemed to think we need everything which can be offered, but there is no place for everything when working with physical constraints and without countless menus. Taking a new look at what the device had to do, provided us with a new insight in what it should do. When designing to create community or unity, which we think should be the case when designing Spotify Party, it is more important you bring people together than, for example, selecting a specific song or replaying the previous song. The device still had to be IoT, because you want it to communicate with Spotify, the speakers, and read the different Spotify accounts as well. In this way the IoB being an IoT device did add to the experience of the product. However, realising we would not need every functionality of Spotify enabled us to create a rich and embodied device, since we choose to focus on community instead of providing as many audio related functionalities as possible.

We therefore argue it is possible to make an IoT device rich and embodied, since we believe we designed a rich and embodied device. Adding the throwing of the ball as an Embodied Facilitation (Hornecker, 2005) to create community, shows us there is place for embodied interaction. The throwing also supports the normally digital data flow of selecting the music. We chose throwing by looking at what kind of expression, and therefore interaction, was needed to tell the device about the mood of the party. It is therefore not only a Tangible Interaction, since we hope to have made the normally digital interaction a non-digital, physical interaction (Hornecker & Buur, 2006), but it also falls into the Rich Interaction Paradigm, since we focused on the interaction needed to guide the data flow (Van Campenhout, Frens, Overbeeke, Standaert, & Peremans, 2013). Our device is not perfect, as we mention in the discussion, nor is it solely focused on physical interaction. We still make use of a menu, but because we believe it is (partially) rich and embodied, and the device undeniably being IoT, we believe rich and embodied IoT devices are possible.

Assignment 3

Based on feedback received on the previous iteration, a new prototype has been made (figure 4). The final iteration demonstrates the integration of a new functionality and the capability of the product to grow. For now, two core functionalities are demonstrated by a physical prototype that, when combined, produces an emergent functionality (Frens, Plasencia, & Zimmerman, 2012). As a bonus, a third functionality is illustrated to prove that the product is able to grow beyond the integration of just a second core functionality. From a technological standpoint this means the system has the ability to interact with other 'new' products, while simultaneously having the ability to grow the social dimension as new people can be introduced while using the product. Thus, presenting a system that can grow into networks of people and products (Frens & Overbeeke, 2009) The core and emergent functionalities along with a technological realisation proposal and a discussion of the design limitations are presented below.

Figure 4: The final prototype: incorporating two core functionalities in a growing system.

To create a growing system (Frens & Overbeeke, 2009) a few alterations have been made to the previous iteration. Where the ball was already visually divided in three sections, these three sections can now physically be taken apart and switched around. It consists of two halves representing a different core functionality, and a mid-section, functioning as a connector piece (figure 5.4). Each half has a connector base with teeth (figure5.9) that grab into the midsection, and finger grips (figure 6) that allow the half to be easily removed.

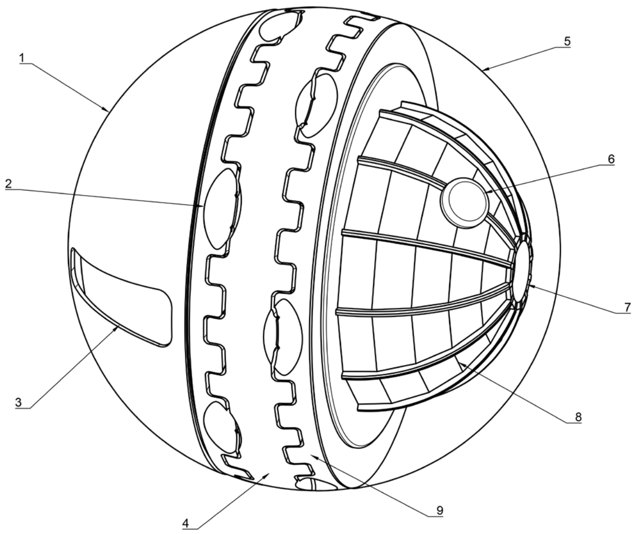

Figure 5: A technical overview of the prototype; 1 Exterior of the music half covered in speaker fabric, 2 Finger grips to afford easy disassembly, 3 Screen depicting playlists, 4 Connector piece for connecting two core functionalities, 5 Clear sphere of the light half, 6 Cursor for selecting light settings, 7 RGB LED, 8 Colour palette, 9 Connector base.

From the connector base upwards each half can be uniquely configurated for its purpose. Each half can be operated on its own, however when two halves are joined an emergent functionality becomes present.

Figure 6: A close-up of the finger grips embedded in every core functionalities connector base

Music

The functionality of controlling the music now resides in one sphere half (figure 7). This half consists of a sphere with an embedded screen (figure 5.3) that can be turned. By doing so one can navigate through the available Spotify lists. Therefore, the screen's only purpose is now showing minimal data and distributing the focus towards other parts of the sphere's interface. Namely the coloured lights that protrude trough the exterior of the sphere, these coloured lights represent other users' playlists. When the screen on the sphere is turned over a coloured light it will display a pulsing soundwave and information about the playlist (figure 8). To select a list, the sphere can be pressed down, the device will then switch lists after the current song has ended, creating a fluent transition. The device can also be thrown to increase or decrease the tempo of the music as described in the previous iteration. To afford throwing, a dummy half or other core function half can be connected to the other side of the sphere half, creating a ball shape. The exterior of the dome is covered with fabric similar to the fabric seen on speaker covers, using feedforward to hint to the user that the functionality of the device is linked to sound.

Figure 7: The music half

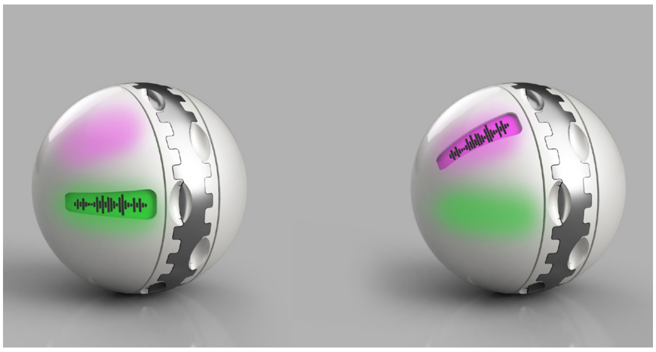

Figure 8: A render illustrating the selecting of different playlists Left: the green playlist is selected, the purple playlist is obstructed by the exterior and only its coloured light protrudes through the exterior. Right: the screen has been turned towards the purple light, making the playlist visible.

Light

The second core functionality is to control light (figure 9). The light half consists of a clear dome on top of the connector base. Underneath this clear dome a colour palette is visible. This colour palette displays all available hues in the lateral direction and displays the light intensity of the hues in longitudinal direction. At the summit of the colour palette a lamp is visible (figure 10).

Figure 9: The light half

One can adjust the hue by sliding a physical cursor (figure 5.6) across the sphere; sliding from left to right will change the hue, sliding up and down changes the intensity of the light. While doing so the lamp in the middle of the colour palette will beam out the selected light preference. By pointing this beam at different smart lamps throughout the house light settings can be 'assigned' to specific lamps. To turn off lights one can slide the cursor all the way down, decreasing the light intensity until it is off.

Figure 10: A close-up of the lamp embedded on top of the colour palette.

Emergent functionalities

When combining these two core functionalities new functionalities emerge. Combining the music half with the light half will unlock a 'party mode' in which the lights will respond to the music. Besides that, joining the music half with the light half also provides a new way to control the behaviour of the lights. Since the tempo of the music can be influenced by throwing the ball, so can the light settings, since these are directly coupled to the music.

When joining the music and light half, the type of music that is played can also be a product of the light settings. For example, when setting the hue to a warm colour the music half will switch to a playlist with relaxing music, to better fit the ambience.

To demonstrate that the product can grow beyond the addition of a second core functionality, we illustrate the integration of a third core functionality; curtains. The curtain half consists of a dome divided in a transparent and opaque half (figure 11). Underneath this dome another dome resides where one half emits light (representing the light from outside) and the other half is opaque. One can for example close the curtains by turning the dome, physically obstructing the light with the opaque side. To open the curtains the dome can be turned again to reveal the light. The more light that is revealed, the more the curtains will open. When combining this half with the music half the curtains will adjust to the type of music, e.g., when a romantic playlist is played, the curtains will close to provide privacy. When the curtain half is combined with the light half the lights will automatically dim when the curtains are opened, and increase brightness when the curtains are closed.

Figure 11 : A render illustrating the curtain half. Left: the curtains are fully closed as the opaque side of the sphere covers the light emitted by the core of the sphere. Right: The curtains are opened halfway, as depicted by the opaque side of the sphere now only covering half of the light source.

Technological realisation

The interactions regarding the music half (throwing and selecting lists) can be supported by the same technology as described in the previous iteration. The light half can control lights using infrared. Since many smart lights already have the option of a remote-control using infrared to control settings, our system can use this same technology. Furthermore, the cursor used to select the hue works the same as Philips Living Colours colour wheel (Philips, n.d.), it only needs a second dimension to incorporate control of the brightness.

The middle section can include all necessary components to make the emergent functionalities happen (e.g., components to support Wi-Fi connectivity, and small processors to connect the two halves). Including these components in the middle section of the device will allow for cheaper production cost of additional halves, and thus makes buying additional halves more affordable for consumers.

The halves can be connected to the middle section using magnets (as demonstrated in the prototype). The magnets are strong enough to allow the device to be thrown without the halves breaking loose, while still allowing easy removal by hand without exerting a lot of force.

Discussion/limitations

Looking at our outcome a few limitations should be noted. To improve the experience in community interplay and to enrich the interaction the procedural element for selecting specific songs present in the previous iteration has been removed. One could argue that this makes the product less useful because it is now no longer possible to select specific songs. However, since our aim is to design an artifact for the theme 'community' and not 'audio', we chose to not incorporate said functionality. Whether the interaction to do so is rich or not, the act of choosing a specific song asks for focussed attention with a device, shortly isolating the user. Therefore, a trade-off was made in favour of maintaining expressive embodied interaction within a group.

Another point of discussion is the explorative nature surrounding the emergent functionalities. The halves of the core functionalities have their own physical and visual cues to communicate their purpose. However, there is no affordance or feedforward that communicates the control of the emergent functionality. We argue that during the sole act of picking two core functionalities with the intent to combine them people will already make expectations of what will happen, and in most cases the emergent functionality is a logical by-product of the two chosen core functionalities (e.g. party mode when connecting light to music). Besides, leaving the outcome open might evoke the explorative side of human nature resulting in an enjoyable interaction. It can be argued that this means the user has to learn the emergent functionalities and therefore does not build upon IoT as it is not self-identifiable. However, this exploratory user experience can also be seen as the playful side of the product: the user has to playfully discover the various interactions that the product can give by combining halves. However, this approach might not cover all possible combinations since in this report only two different combinations have been explored. More complex core functionalities might be added to the system at later stages that allow for more complex emergent functionalities, making it harder for the user to predict and learn these emergent functionalities. To learn if this playful exploration is appreciated by the products target group or not would require future user testing.

At last, there is still room for more expressive interaction possibilities within the additional core functionalities. The product has the form of a ball and therefore has the affordance to be thrown, bounced, spun around, etc.

But how about rich and embodied IoT?

The addition of an extra theme and keeping the product as a rich interaction product seemed an impossible challenge. Rich interaction, as we understood it at this point, was a very specific interaction that was extremely tailored to one interaction. Especially since we wanted to keep the ball shape since this shape was very important for the community interactions. Designing two separate products that could interact with each other was also not an option. If the system would grow more, we would need a third device and so forth. Until we would have a plethora of products, recreating the "many remote controls problem" instead of a growing system.

We wanted to keep the ball shape and not create many different products, but rather create a hub of control capable of growth. When we evaluated our three interactions: rotating, pressing and throwing; and compare these to our before mentioned definition of rich interaction, namely specific and tailored interaction, then we see that our interactions are not very specific and tailored. However, we do find them to be rich interactions. Now how can this be? Our interactions are not specifically based on the functions they are mapped to but are based on interactions that the shape of our ball affords (Gibson, 1986).

This insight meant two things: one, we had to enhance our interactions for more feedforwards; two, we could crack the puzzle of adding a second theme by working from the affordances to functions instead of working from wished functions to interactions. First, enhancing our interactions. Since our interactions are afforded by the ball but not necessarily tailored to the interactions they are mapped to, they needed visual but also emotional enhancements. For example, on the community side users are represented by coloured lights (figure 8). However, only one user is not blurred, and the other users are represented so that rotating the half to change user is communicated. Furthermore, the lights pulse to the rhythm of the music, further indicating that this is connected to the music.

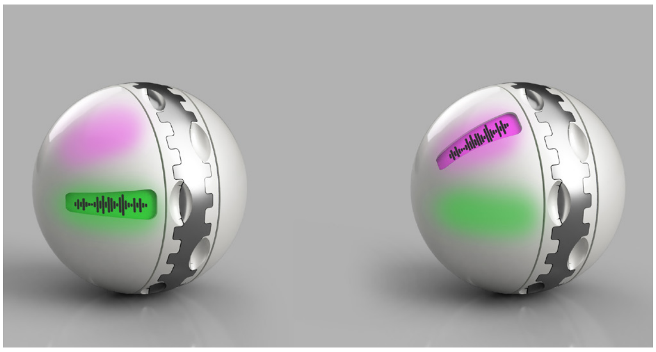

Figure: 8 A render illustrating the selecting of different playlists Left: the green playlist is selected, the purple playlist is obstructed by the exterior and only its coloured light protrudes through the exterior. Right: the screen has been turned towards the purple light, making the playlist visible.

Second, working from affordances to interactions. Since we want to keep the ball shape, we work with the same affordances and therefore have the same possible interactions to map functions to. In this case we can apply the same process to the theme light. Mapping functions to the interactions and create a visual, rich feedforward. To really test this process, we applied it to as many themes as we could. Here we did run into some learnability issues. Because the product is always a combination of no more than two halves, using more than 2 halves and different combinations can create confusion. However, since our interactions can be explored, functionality can be learned through use instead of through reading an extensive menu. Again, we believe that this is a power of using rich interaction as an approach for growing systems.

We believe that rich interaction can greatly improve the ease in making a growing system. Creating a growing system with the mindset "what does my product afford?" instead of pushing as many functions in one device as possible can really help with creating IoT systems with the capability for growth without confusing the user.

Conclusion

General reflection assignment 4

Throughout our project process and while reading related literature we gained a deeper understanding of what rich and embodied interaction means. When trying to apply the theory and explore this within our design concept, we noticed through hands on experience it is not always as fitting and user friendly as we expected it to be. We do strongly believe rich and embodied interaction with connected IoT products is possible, only that it does carry a limitation. We expect from this brief experience that in many use cases solely making use of rich and embodied interaction possibilities in IoT products will lead to a decrease in functionalities. Therefore, we came to the conclusion that a modular approach (Frens, 2017) would be the optimal solution, as it allows unlimited growth and thus unlimited emergent functionalities. The question designers need to ask themselves is if potentially sacrificing certain functionalities is worth the increase in rich and embodied interaction in their context. While a designer can easily put endless amounts of functionalities and buttons in an app this is much more limited when working with physical products and embodied interaction, especially in growing systems where new functionalities that need new controls might be introduced at later stages. We believe not every IoT device needs these limitless functionalities and expect certain situations lend themselves tremendously to enjoy a rich and embodied interaction style.

Conclusion

This experimental design journey aimed to design a modus operandi for a home IoT system, revolved around community and light. The process towards designing such a product involved a process of several iterations and assignments. Finishing with an interactive embodied ball that has connectable halves, allowing for a growing system. Each half can function individually and can be physically connected with another half to create an emergent functionality. Limitations of the final design consist of a lack of feedforward with regard to these emergent functionalities and a limited amount of controls. It can be argued that the final design is too complex for the user to understand without essentially exploring and learning what the emergent functionality of two core functionalities is. Whether this explorative learning process is actually an obstructive or enjoyable facet of using emergent functionalities in IoT systems needs to be further explored.

The intention was to design a product that has rich and embodied interaction while offering the user growing functionalities, using a modular design. We believe rich interaction within the scope of IoT is possible if the focus is not on offering as many functionalities to the user as possible. The general image of IoT devices is that you should be able to perform as many actions with one device as possible. However, using technology currently available, a balance exists between the number of functionalities that can be provided and the amount of rich interactions to control these functionalities. In our opinion a trade off can be made between functionality and rich interaction, albeit in the right context. Like our modular device, where certain functionalities such as choosing a specific song are removed in favor of rich interaction controls. In our case this could be done as removing certain very procedural and individual interactions contributes to the design goal, which is creating a device that improves community/unity.

Our direction and take on designing with rich interaction were focused on entertainment and human connection. However, we have come to realize that rich interaction can also be very meaningful for other sectors such as health. Rich interaction can improve the users understanding of the interaction and effectiveness of a device. Therefore, generally we believe the added value of rich and embodied interaction weighs up to potentially losing some of the functionalities of a design. Nevertheless, a lot of future work remains to be done to discover the ultimate balance between rich interaction possibilities in relation to functionality. Even so, we believe that there exists a strong potential for the virtue of modular designs.

Reflections

Kyara Fasen

Related to my vision, I've mainly worked on projects for the health care sector during my master. Clear interactions with the product are very important when designing for this user group. There is little room, or might as well no room, for mistakes. This is why in my concepts I'm always speculating about how to improve my user-product interactions, and why I chose to follow this course. How to create feedforward so clear that even a user with dementia would know how to interact with my products.

But time after time my ideas will get shut down in the very early-phases of my process by contacts in the hospital.

"You are thinking too difficult, just make it an app! Much more convenient!"

But this never sat right with me, is an app really always the best and most convenient way to interact with a smart product? I had yet to accept this, since I myself can at times strongly dislike having all these different apps to control the tv, music and lights around the house. And can get nostalgic towards the physical actions of for example putting a record on, making it a much more conscious action.

Only I never had the vocabulary to back this statement up.. especially in the strict healthcare sector.

So you can imagine my surprise when during one of the first lectures of the course healthcare already came up as one of the scenarios where richer interaction can really be of value. This moment was a real eye opener for me.

Learning about the four approaches to design for rich and embodied interaction in IoT helped me to categorize my own ideas and points I recognized from working in this sector.

Plus it served as a starting point of inspiration for creating new ideas for interfaces in my project. I see many opportunities for rich interaction to better healthcare. These more conscious actions I was talking about earlier can help prevent mistakes, and through playing into the affordances of objects and shapes I can make objects so intuitive they can potentially even be used by patients with dementia.

Lastly I want to quickly note that also within this course I got to work with the idea of a growing system for the first time and together with my teammates discovered how to design within the framework. Possibilities for growing systems is definitely an important point to keep in mind also for the healthcare sector. With more and more care moving to rehabilitation at home, it is important the designs we make today will be compatible with the possibility for growing functionalities in future expansions of this at home care.

So I want to thank the lecturer Joep for helping me extend my vocabulary and providing me with handles to present a strong base when I will be making my argument to include embodied interaction in my FMP proposal. I am excited to challenge the visions of healthcare workers who probably believe design is something for people with too much free time and convince them how embodied interaction can be rich and work in their advantage.

Jay Kolvenbag

In previous years I have avoided everything that had anything to do with IoT, both as a consumer[1] and as an IDstudent within the faculty.The IoT products currently available have simply no added value for me personally (on the contrary), therefore never evoked any personal interest, and designing for it seemed like a difficult obstacle. However, reading the course description sparked my interest, mainly because of the alternative approach on designing for IoT. At the start of the course designing growing systems for IoT seemed extremely difficult and hard to grasp. In hindsight I still find it extremely difficult except now I have a better grasp on the subject matter and have learned ways to approach a growing systems design challenge. One of the most valuable insights gained during the course when designing for growing systems are the four approaches to design for rich and embodied interaction in IoT (Frens, 2017). Especially at the start of the process I was struggling to find the right approach to tackle the design challenge, I noticed I was designing for something I did not yet fully grasp. Learning these approaches helped me to categorise our own ideas and served as a starting point of inspiration for creating new ideas for interfaces. What also helped was the way the assignments were structured, starting from one core functionality and then adding a second helps to demarcate the design space and makes solving the limitations of your design that you encounter manageable. Both are learning points I can employ in future projects when designing for growing systems.

Looking back at the group work, the dynamic within the group was overall very pleasant. We did run into some slight obstacles where expectations weren't always met due to a lack of communication. However we always managed to solve matters cohesively and adequately.

After making a rich and embodied growing IoT device, I am personally convinced that there is a place for rich and embodied interaction in IoT, albeit to a certain extent. I say that because I feel limited by the technology currently available. I have now experienced first hand the difficulties of designing controls for complex functionalities using rich and embodied interaction. In our design this resulted in a simplified version of spotify party with rich and embodied interactions that supported the theme it was designed for (community). However if this was sold as an actual music control device you would probably not get away with reduced functionality. Therefore, I think shape changing interfaces might have great potential as a modus operandi in growing systems. However, the resolution currently provided by SCI does not allow enough versatility to support ever growing systems. For the remainder of my masters I will be working on programmable materials, and hope to contribute to the field of SCI, and through that avenue indirectly to the field IoT.

[1] I must admit that I do own one smart light bulb and I find it terrible.

Mirthe Visscher

Within this reflection I will discuss my expectations, learning goals and final takeaways of the course DCM110 *A designerly perspective on IoT*. I am an empathic, business and user focused designer. Therefore, my main expertise is not prototype design of the area of Technology & Realization, however I still wanted to develop more knowledge on the way interactions in products can be encompassed and reach maximum value for the user. Furthermore, as IoT evolves and more products become part of the growing network, I believe a designer has gained the responsibility of having the knowledge to design such connected products.

During the course I got familiar with what it means to design for IoT. That such a design builds upon three pillars; be identifiable, be able to communicate and to interact with other products or among themselves. In fields like healthcare this often results in products that are digital and offer the user numerous functionalities instead of being focused on creating valuable interactions for the user. This is where rich interaction could make a difference and is therefore important to include when designing for IoT systems. For example, when designing for a user group of visually impaired people, a rich interaction, with clear feedforward and feedback, could create a better user experience than adding 'plain' functionalities and procedural elements. Especially for products in the context of growing systems that allow for the continuous introduction of new entities in a network. Rich interaction gives meaning to actions and communications of such products that would have otherwise remained in the unknown, giving more value to the user. In the context of dynamic homes, this could mean that the colour of the outer wall indicates how many people are in the living room or what the status is of the person working in that other room. Nevertheless, to make sense as a product in an IoT context, one must include rich interaction in combination with functionality, the focus should not entirely be on designing 'plain' functionalities.

Growing IoT at the same time opened up a new perspective for me. As it's dynamic properties also open up the ability to combine functionalities into emergent functionalities.For me as a designer it means gaining opportunities to continuously grow the functionalities of the product you are designing. Thus, providing your user with more value as a product no longer has a singular meaning, but can be combined to attain new meaning the user needs. Another learning point that I believe is important for my future design projects, is the affordances of objects. Just like a cube allows it to be rolled but not bounced, a ball affords to be thrown not to sit on. Designing interactions based on the affordances of the material or object you are working with, can improve the user experience as designs can feel more 'natural'. It also at the same time means that you as a designer are not just designing a probe but using the natural properties, affordances, it already has.

Lex van Heugten

I joined this course with the reason: "I don't like the trend of IoT products, I better learn something about it". And I did learn one or two things about it. I learned what I specifically disliked about IoT devices nowadays and a perspective on IoT design that I will take with me through my professional career.

The feeling of disagreement that I felt towards IoT products came from the tendency to connect everything to everything. How much data and functionality can we stuff in a smart watch? Rich and embodied design seems to force the designer to take a breather and think about what the user really needs to interact with. Do I really need to put a stress meter in my smart watch? Probably not. Our design for assignment 2 was based on a embodied interaction that required emotional capabilities to act with. Namely, throwing a ball to set the mood of the music. Then, we cluttered our design by adding as many functionalities as we could possibly fit.

The feedback sparked discussion within out group. What is rich interaction, what went wrong? We took a step back and reflected which parts of our design did not serve the core functionality and which part where embodied interactions just because we could. In this discussion I developed a view of what I think rich interaction is and should be.

Of course, rich interaction is the extension of interaction beyond procedural menus and buttons filled with symbols. Using the skills that humans have developed over the ages in their natural and social environments to enrich how we interact with our products. However, I don't believe that using a menu or a button is evil incarnate. The conclusion of my group reflects my own opinion that an hybrid approach is probably the way to go. But I do think that rich and embodied interaction should always be used in service for the core functionality of the product.

For example our own IoB. the core functionality was creating a musical mood with all the guests at a party. Using embodied interaction to change the volume was also added at first but the feedforward was nonexistent. The ball shape afforded the specific embodied interaction but because it was not the core functionality for the product creating extensive feedforward would probably been distracting. I think that the design at this point would have been better for it with two buttons on it with a plus and minus to change the volume.

In conclusion, I see rich interaction create radical new ways to interact with our products in the future but I believe that it can coexist with procedural and semantic based interaction we use today. I am glad this course challenged me to design rich interactions and with it my outlook on design and interaction. I look forward to using this mindset to enrich my own designs in the future and create new ways to design interaction that use the complete human spectrum.

Minne Zeijdner

I chose this course because I always felt a great dislike for IoT devices. I'm very opposed needing a screen to be able to do stuff, especially because this usually means using a smartphone and I want people to be able to live without their phone. I thought choosing a course in a subject I dislike could teach me about what I exactly dislike and why I should dislike it. Also, broadening your horizon by looking at something you'd never looked at otherwise, is always a good idea in my opinion.

During the first two weeks I already realised my dislike for IoT devices did not come from the concept of IoT, but how most devices were designed: you need a phone. I knew that when I go to bed or am hosting a get-together, I want to be able to control the lights without seeing the input of Whatsapp, Facebook, Teams, or any of the other amazing apps I 'need' to have on my phone, which is why I dislike designs that need a smartphone. However, I never thought of changing the design to something that doesn't need my smartphone anymore. Mostly because I thought I needed all the functionalities or options a device gave me, and a screen is the easiest way to communicate all those functionalities. But also because I wasn't able to separate the IoT from the screen or smartphone.

This insight did not only teach me to look IoT devices differently, my way of identifying a problem in a design reached a new depth. Before I took this course I was able to look at a design and think "This is shit," and motivate that opinion by saying something like "because the placement of the button is confusing". However, I never looked beyond the dimension the design was in. I would've never thought of IoT as something with potential, because I couldn't separate it from a screen or smartphone. In my mind the whole thing was wrong, because the interaction I was having with it was wrong. This course taught me to identify what I like and dislike, and pull both out of their context, to see the potential or create something better.

When signing up for this course, I did not expect I would end with a changed PI&V. I have had an interest in data science and AI for quite some time: we can make products more personalised, or show climate change is happening and what the consequences will be in 10 years. However, usually, the personalisation or the showing of a consequence happen in a visualisation, like a Netflix environment or a graph, which I always believed to be quite flat. This course showed me it can be more. What if I can personalise the physical remote control? Or what if people can experience what it would be like to breathe in 10 years? This is what I'll be taking with me during the rest of my master.

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