Title	TOMTE : third-party affective evaluation of human to human interactions
Sub Title	
Author	Knives, Ian(Inakage, Masahiko) 稲蔭, 正彦
Publisher	慶應義塾大学大学院メディアデザイン研究科
Publication year	2016
Jtitle	
JaLC DOI	
Abstract	
Notes	修士学位論文. 2016年度メディアデザイン学 第512号
Genre	Thesis or Dissertation
URL	https://koara.lib.keio.ac.jp/xoonips/modules/xoonips/detail.php?koara_id=KO40001001-00002016-0512

Master's Thesis

Academic Year 2016

"TOMTE": Third-Party Affective Evaluation of Human to Human Interactions

Keio University

Graduate School of Media Design

Ian Knives

A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
MASTER of Media Design

Ian Knives

Thesis Committee:

Professor Masa Inakage	(Supervisor)
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Abstract of Master's Thesis of Academic Year 2016

"TOMTE": Third-Party Affective Evaluation of Human to Human Interactions

Category: Design

Summary

With smartphones, smartwatches and other devices containing sensors becoming widely adopted, the question of using, analyzing and changing user experience with this data is becoming more important every year.

This thesis takes from the research on an IoT device called the Social Mascot or TOMTE, developed as part of "Play" real project joint research with Ericsson in the "Social Things" group. Actively analyzing data-driven interactions of its owner, TOMTE aims to give emotional feedback on the owner's interaction it have observed. By actively signalizing on the state of current interaction TOMTE adds new layer to the usual flow of human communication. By following up and giving its feedback on the recent social activities of the user, TOMTE can suggest new connections, becoming a good trigger, reminder and conversation topic.

The prototype analyzed and discussed in this thesis is a minimum viable production design, that explores how can conversations change in case of immediate feedback and the users reaction to the follow up, emotional reports by TOMTE on a social interaction.

Keywords:

IoT, Affective Evaluation, Social Things, Emotional Tracking

Keio University Graduate School of Media Design

Ian Knives

Acknowledgements

We used to believe so firmly, you and I, in the unity of existence; but now I glance back - and it is astounding - how impersonal in color, how unreal in pattern you have become, my youth.

Vladimir Nabokov

I can not thank enough my academic adviser, Masa Inakage, for leading his project and KMD by example. I also want to thank every professor, who shared his guidance or help during my time at KMD: Okude-sensei (vivat design thinking!), Kai (Danke schoen fuer seine Hilfe), Matthew, Sam, Sunahara-sensei, Kato-sensei, Yamanouchi-sensei, Kishi-sensei, Okawa-sensei, Charith and all the others. You are the best teachers I ever had.

I want to extend my academical gratitude to Uriu-sensei and Chihiro-sensei. That time was brutal, but it taught me a lot.

I want to mention every person, who I met during my KMD life, but I am afraid I will run out of space too quick. I just want to specially thank my sempais: Terence Chen and Jimi Okelana. You guys taught me all the survival skills. It was brutal. But fun. But brutal.

I want to specifically thank Champ for helping me during this busy thesis period.

All the other amazing people: I love you all. Kiyo, Kay, Isis, Sam, Jenny, Ando, etc.

Final thanks to my mom and Mizuki!

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Chapter 1
Introduction

TOMTE, a device proposed in this thesis, is a social assistant which is used in a setting of party or during a social interaction. Leveraging on the concept of third-party affective evaluation. TOMTE records, analyzes and interacts with a user based on its own observations. TOMTE strives to be useful as a friend, but it does not afraid to have an opinion that might be a bit different from a user's perception.

The ideation process of TOMTE heavily relied on design thinking method with two fieldworks concluded. These fieldworks gave extensive inspiration for a lot of design decisions. At the same time, TOMTE has a defined preferable user-base described as its target persona and these people will get the most from the concept. In order to fully implement the concept, three layers (physical, data analysis, application) have been designed, built or simulated.

1.1 Social Web of Things

This thesis heavily relies on the concept of Social Web of Things, that was defined by Ericsson Design Lab[1] and presented at the GSMA Mobile World Congress in 2011 and 2012 in form of two concept videos and one prototype video. In their research, Ericcson proposed a new way for objects to interact with each other and user in emotional way that is easy to relate and understand, creating a social web network for a user's ecosystem.

Based on this concept, a real project named "Social Things" was conceived inside Keio University Graduate School of Media Design. Social Things were developed as autonomous connected objects, that value interaction with other Social Things in a same way as interaction with the user. Three important characteristics of Social Things have been defined in the process of group research:

• **Equality to humans:** Social Things are not subordinate to human, but exist

on the same layer. Social Things might have their own desires, wishes and community.

- **Ability to learn:** Social Things do not come with a fixed personality, but constantly learn, adjusting their personality in a same way as humans do.
- **Fluid community:** Social Things are always ready and curious to cooperate with other things.

1.2 Current situation and motivation

Technological changes

The rapid technological progress, which leads to miniaturization of electronic components, as well as economical effects of scale in production and supply in labor force are changing the landscape of technology, leading to practical implementation of the IoT (Internet of Things) concept, which crystallized in late 1990s, but was discussed long before. Humankind is on a technological stage, where daily use devices like smartphones and smartwatches have their raw sensor data available to use and analysis. With smartphone penetration rate of around 56.2% [2] there is a solid foothold for the fast adoption of the new devices and concepts, which rely on this data.

This sensors are measuring all kinds of data, which can be divided into two main categories: human data like daily activity, sleep tracking, and heart rate data which is directly related to the user and environmental data like temperature, ultraviolet ray activity, atmospheric pressure, which affects user indirectly. While the environment data is measured for a long time, sensors that are both cheap and reliable enough, that can grab the human data is a very recent development.

Now the market is becoming more and more saturated with devices recording the human data, but interpretation of this data is still a challenge with most of devices on the market having only the most simple interaction. Fitbit Charge HR, owned by the author of this thesis, showed itself as a good and reliable product, but after a while I stopped carrying it: there were no interactions that really made me want to use it.

Author believes that this trend changes with start-ups actively exploring into more creative interactions with this data, some of which are analyzed in Chapter

2 of this thesis. This motivated author to personally look into the market and was one of the reasons for igniting the initial research.

Societal changes

We also live in an era when distances start to matter less and less, both in physical and virtual sense. Chinese airlines are actively damping on a price market [3] with hundreds of new flights, not only creating new routes but making the current routes cheap enough for an average person to travel more frequently. It truely makes the world more global in a physical sense.

At the same time if we step back and remember again that messaging apps and social networks which became a well-established, daily part of our lives and which connect us to friends from all over the world. These changes again directly affect our daily lives too: some say that our offline interactions are becoming more shallow and switching to the virtual plain, but I see this as an opportunity: you never know from where the person you meet tomorrow might be and when and how you will interact with them again.

To sum it up, society is becoming more global and diverse because of economical and technological reasons, and author was motivated by this fact to undertake his feildwork research and strongly believes that best design is possible from observing a diverse environment.

1.3 Thesis structure

This thesis consists of five chapters. The next chapter looks into the concepts behind the design process, as well as shows some competing products and problems they have. Chapter 3 describes the whole concept of design creation from scratch to a minimum viable working prototype, giving reasons and explaining the design decisions. A prototype test is also conducted in this chapter. Chapter 4 validates the concept by interviewing potential users, highlighting achieved points and displaying some points that may require additional work. Finally, Chapter 5 concludes the thesis and outlines possible future research.

Notes

1 http://www.ericsson.com/uxblog/2012/04/a-social-web-of-things/

2 https://www.statista.com/statistics/257044/smartphone-user-penetration-in-japan/

3 https://www.bloomberg.com/news/articles/2016-12-12/china-s-flood-of-cheap-air-fares-deals-blow-to-global-carriers

Chapter 2
Related Works

2.1 Third-Party Affective Evaluation

Proposing a device based on the concept of third-party social evaluation requires a clear understanding and definition of the concept, so it can be applied for the design purposes. The concept of third-party affective evaluation, also known as social eavesdropping, is analyzed in the field of behavioral psychology. It was initially defined in the human psychology research with ability to understand how to distinguish between potentially harmful people and people who might help you being crucial for our existence in the social world (Hamlin and Wynn 2011).

When avoiding a group of people, who might loudly argue with each other, we consciously label them as dangerous, observing such indicators as their emotions, manifested in shouting, facial expressions and other indicators, that are very clear for humans, with infants as young as 6- and 10-month-old taking into account an individuals actions towards others in evaluating if that individual is appealing or averse. It was discovered that infants prefer an individual who helps another to one who hinders another, prefer a helping individual to a neutral individual, and prefer a neutral individual to a hindering individual (Hamlin et al. 2007).

A recent 2015 study by Chiijiwa and others was conducted in the field of animal behavioral psychology, specifically, the dog psychology. It is well proven that the dogs are highly sensitive to human actions directed at dogs, but the topic of dogs being sensitive to third-party interactions was under debate (Chijiiwa et al. 2015). The study involved dogs observing a third-party interaction between their owners and another person, playing a role of either a helper or non-helper in a simple task of opening the container. It was clearly proven that dogs preferred not to interact with non-helpers, avoiding that actor and refusing to take food from it (Chijiiwa et al. 2015).

Dogs have demonstrated “an assymetrical preference”, with actively avoiding non-helping owners, but showing no clear preference for a helping actor, which

contrasts with the aforementioned study by Hamlin, Wynn and Bloom, where human infants have in fact preferred the helping individual, so it can be argued this is a preferred way for humans to process results of third-party affective evaluation.

2.2 Distance in Social Interaction

Proximity between a user of Tomte and the other party is the key concept to be employed in data analysis for interaction feedback. When people speak to each other, they need to be close or otherwise you could not hear another party. The modern concepts of proximity in interactions have been described by anthropologist Edward Hall back in 1969 in his book "The Hidden Dimensions", where he divides the social distance into 4 main distance zones:

- **Intimate distance:** between 0-50 cm, a distance people usually have in a close relationship or during a heated argument.
- **Personal distance:** between 50-120 cm, a distance people take when interacting with family members or close friends. People speak quieter when interacting with someone in that distance zone.
- **Social distance:** between 120-350 cm, a socially acceptable distance between co-workers in a workplace or at a social gathering.
- **Public distance:** 350 cm. and more, a distance usually reserved for public speaking or another interactions between 1 and many. Requires speaking in a louder voice.

At the same time, there are obviously some factors that affect the social distance, which were summarized in the 2015 study on proxemics by Nicolai Marquardt and Saul Greenberg, "Proxemic Interactions: From Theory to Practice".

- **The environment:** people might need to be closer to each other in a noisy environment of a cafe or of a nightclub.
- **Gender and age:** on an average, distance between two females is smaller than a distance between two people of different gender.
- **Cultural background:** there is an observable difference between an Argentinian and a Japanese person.

- **Relationship to the people around:** people tend to be closer to people they know and like.

2.3 Friend Suggestion

A feedback on the recent owner's interaction has a lot in common with the friend suggestion mechanism, employed by main social networks, as essentially these two procedures share the same goal: bringing new connection a user might have missed otherwise. The analysis of friend suggestion mechanisms in major social networks will follow:

Facebook

"People you may know" is one of the integral features of Facebook, available since the early days of the social network. Facebook themselves do not disclose the algorithm, listing "mutual friends, work and education information, networks youre part of, contacts you have imported"[1] as the factors they use for the friend suggestion mechanism, though brief mention of "some other factors" is a good indication of some other factors not being revealed.

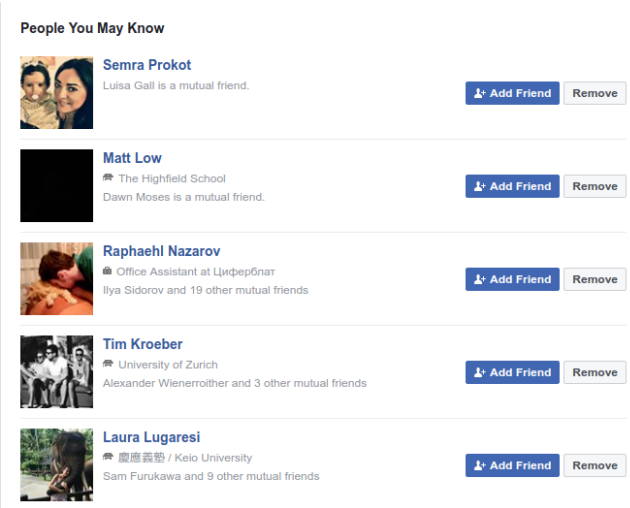

Figure 2.1: An example of Facebook friend suggestion page (source: Facebook)

As seen in the author's example, Facebook is mostly suggesting friends based on the number of mutual connections. It is worth mentioning that author is

connected to the first person in the list through only one common connection and possibly there are some other factors involved in deciding priority in the list.

Some other factors that are not mentioned by Facebook directly, but either directly confirmed or strongly possible are: smartphone geolocation[2], although Facebook have retracted the statement later(Hunt 2016), and checking on whom do you look up and who looks up on you and suggesting those people, despite having no other connections[3].

Still, Facebook's friend suggestion mechanism is providing only a technical, brief information on a person you might now, without evoking any emotions in the user. Facebook gives no attempt to connect to these suggested friends on emotional level, for example, by sharing and highlighting their posts you might find important.

Line

A messaging service Line, a popular application in Japan, uses the same standard methods of friends suggestion: mutual friends and shared contacts. Again, there is no emotional connection to the potential friends with information presented in a very dry and minimalist manner.

Twitter

Twitter, another famous social network, has the functionality to suggest new friends. Compared to the Facebook and Line, we can observe the short description which users have to write about themselves as part of Twitter functionality. As these descriptions are user-generated, they might be used create emotional stimuli to click at the profile and least open the profile and read the profile you might be interested in. At the same time, if you have any followers in common, Twitter shares this functionality too.

2.4 Technology review

In order to implement and realize the third-party affective evaluation concept, a technological review was conducted and three main streams of data for observation have been identified: heart-rate data, proximity data and voice data. A common motivation for picking this three technologies included availability of sensors, so

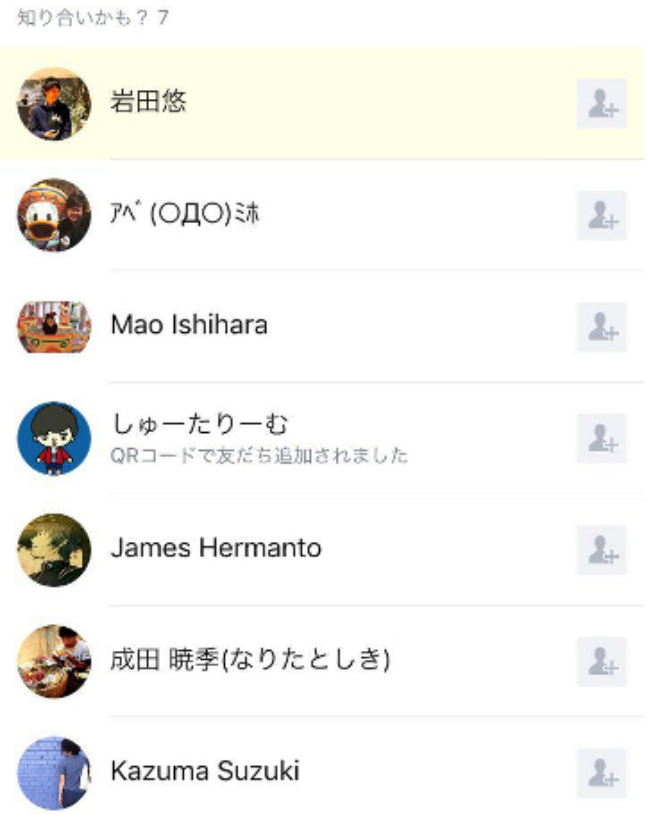

Figure 2.2: An example of Line friend suggestion page (source: Line)

Figure 2.3: An example of Twitter friend suggestion page (source: Twitter)

prototype can be realized in physical form, possibility to relate and understand by the users, as people unconsciously observe the volume of conversation, distance to another people and relate to their personal heart rate, when they feel really nervous or agitated; with Japanese onomatopoetic words like doki-doki proving there is unconscious understanding of heart-rate importance. Further I will analyze every stream of data and review applications and devices which use it.

Current usage of heart rate data

Heart rate data measure became a mainstream technology in last 2 - 3 years with heart rate sensors being massively available for manufacturers and enthusiasts in form of components and sensors, and for a mass market users in devices that use these sensors. The most widely used commercial technology have been proposed in 2010 paper by Hashem et al., who described it as "two high intensity LEDs that illuminate the tissue and a Light Detective Resistor (LDR) whose resistance changes according to the amount of light transmitted from the tissue" (Hashem et al. 2010). In case of blood, more light is being absorbed than in case of a tissue, which allows identification of blood flows, that correlate to BPM. The system proposed in the quoted paper used index finger to identify the blood flow, but most of the current commercial sensors use human wrist, which comes along with well established practice of carrying watches. An example of commercial heart rate sensor is provided on the figure below. In case of further development of power sources, we can have a ring-like device for the same purpose, but currently a watch form factor is the most commercially available.

Most of the current commercial devices that have heart rate data sensor use it for the following purposes:

- **Physical exercises identification:** When users are exercising, their heart rate usually goes up, which allows to locate and identify periods of physical activity.
- **Sleeping state identification:** When users are sleeping, their heart rate drops significantly compared to the activity period, which allows to locate and identify periods of sleep.
- **Sleeping:** When users are sleeping, their heart rate drops significantly compared to the activity period, which allows to locate and identify periods of sleep.

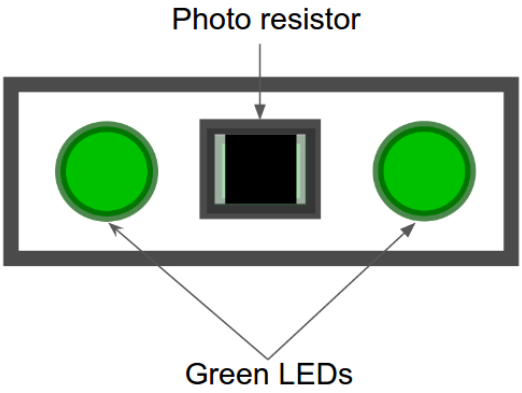

Figure 2.4: A modern commercial heart rate sensor scheme

Fitbit Charge HR, one of the commercial products that have been widely sold throughout the world, have both functions preinstalled in it's software, applying these algorithms to automatically identify physical exercises or resting periods, with detailed graphics for every day available for analysis by the user.

Yet according to the research by Endeavour Partners, concluded in 2014, 1/3 of the users abandon their activity trackers after 12 months (Ledger 2014). In an 2016 interview in the Fortune, Fitbit CEO James Park claims a retention rate of 78%, which still means that 22% of the users stop using the device (Cipriani 2016).

The author believes that the main reason for people to abandon such commercial products is because there is no emotional connection between a raw heart rate data and a user. The daily graphics of heart rate is only a data, and without any conclusion coming from this data, there is no way for users to relate to their devices.

Emotional tracking

While fitness and health usage of heart rate data is the main current commercial application, a new trend for emotion recognition and tracking with heart rate data is being clearly present, though no products have yet made it to the market. Emotional tracking as a main function is presented for the three devices, that will be analyzed below:

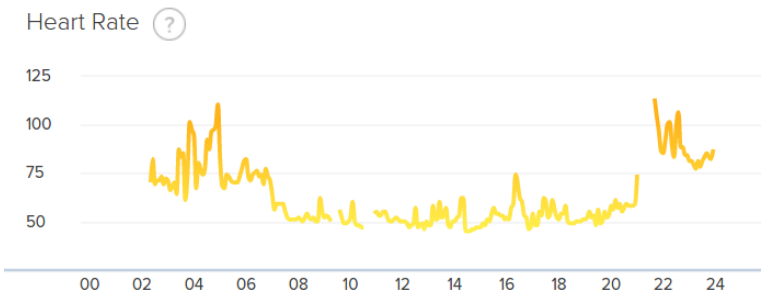

Figure 2.5: Heart rate daily analysis by Fitbit Charge HR

Feel

The product named Feel, which was announced in January 2016, is using heart rate sensor, galvanic response and skin temperature sensor, with proprietary algorithms that link this data in order to recognize the user's emotion [4].

The product itself consists of two parts with a bracelet with all the embedded sensors and an application, that processes the sensor data, recognizes emotions and gives feedback. The stated goal of the system is "improvement of overall emotional well-being" [5]. The product is still not on the market, but the developers claim it will not only the emotions, but will make suggestions on how to improve emotional well-being. Developers also plan to release the API for their product, providing third-party developers possibility to develop scenarios, that are linked to user's current emotional state [6].

Zenta

Zenta is another recent product in developement, which got succesfully crowd-funded on Indiegogo in July, 2016 with a USD$272,289 of total funds raised out of initial goal, USD$100,000. This demonstrates big public interest and anticipation in emotional tracking devices being released. Zenta uses the set of sensors that is same to previous product, but tries to visualize and make users feel connected to their heart rate data more, with possibility to share your emotions with other people and an "interactive touch that syncs with your body in real time', which allows to 'feel your heartbeat through the wearable" [7].

Figure 2.6: Feel, an emotional tracker

2.5 Discussion

The concept of third-party affective evaluation, coming from behavioral science, is the natural way for the further development of the Social Things concept. Social eavesdropping, a concept that we learn to use since early infanthood and can also find in our pets. Applying the concept from behavioral science to design of Tomte helps users to easily understand the mental model of the product. The psychological difference between dogs and humans with dogs only actively avoiding non-helping agents and humans building a priority pyramid with preference for a helping agent is another concept, that will be implemented in the way Tomte interacts with user, with Tomte taking the human approach in evaluating other individuals.

Notes

1 https://www.facebook.com/help/www/501283333222485

2 http://fusion.net/story/319108/facebook-phone-location-friend-suggestions/

3 https://www.reddit.com/r/OkCupid/comments/3cy24i

4 http://mashable.com/2016/01/12/feel-emotion-tracker-wearable/

5 http://www.myfeel.co/

6 http://www.wareable.com/wearable-tech/feel-wristband-specs-price-release-date-details-2148

7 https://www.indiegogo.com/projects/zenta-stress-emotion-management-on-your-wrist

Chapter 3
TOMTE

3.1 Previous design work

One of the key concepts, on which the further design research is based is the infrared communication concept, which was developed by the Social Things team: Jimi Okelana, Champ Assavaniwest, Kiyo Wilbur and Ian Knives with support from other project members. The concept was displayed in a form of demo during the KMD Forum in November, 2015 with thesis author being responsible for writing the software and developing the schematics for Arduino prototype. The name TOMTE itself comes from this concept.

In initial idea and design sketch, our team wanted to display TOMTE as social devices, that have their own conversation independent of their own masters conversation. At the same time we wanted to somehow connect this communication between TOMTEs to communication between their masters, in a same way as pet dogs would have conversation, when their masters approach and greet each other. A proposed scenario was brainstormed and illustrated by Jimi Okelana and our team looked into technological realization of this sketch.

Infrared communication concept introduced a way for TOMTE to communicate with other TOMTE, using the infrared (IR) communication. Compared to more modern protocols of network communication, which use radio-waves like Bluetooth, Wi-Fi or ZigBee, IR communication has a limitation that is caused by the nature of IR itself: receiver and transmitter need to be in direct visibility, as IR could not penetrate through the walls or most of the other usual objects. The sensors that are mostly used in IR communication also generate a very narrow beam, which further emphasizes the importance of direct visibility. The simple explanation of basic principles and the limitations of IR is provided on the figure below.

The Social Things team decided to leverage on the limitations of IR communication, turning into advantage: direct visibility, that is required for IR commu-

Figure 3.1: A sketch of communication between TOMTE devices

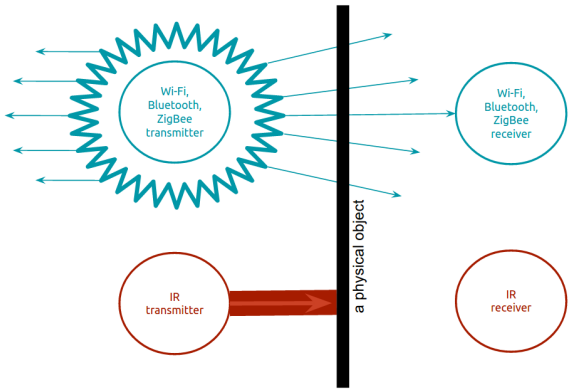

Figure 3.2: Main principles and limitations of IR in comparison

nication, can be compared to human-to-human communication, which involves direct eye contact in most of the cultures. Moreover, we theorized, that communication between mascots in such way could be clearly visualized and understood by visitor of any background, which was the purpose of our demo.

The demo involves two TOMTE devices, attached to a rotatable mini-columns, which allows to alter the position of TOMTEs. Both devices have IR transmitters and receivers inside allowing two-way communication between devices. In the initial state, the transmitters are pointing into different directions, so two TOMTEs can not "see" each other. When a visitor approaches the demo, an exhibitor would rotate two TOMTEs, so they face each other, which starts an interactive conversation, animated by blinking LEDs, highlighting every step of the conversation.

Figure 3.3: IR communication demo at KMD Forum

A conversation goes through three phases: first, TOMTEs notice each other. One of the TOMTEs would start blinking in a "greeting" animation, which would be noticed and repeated by another TOMTE. Then both devices go through "surprised" animation, finally saying goodbye to each other using the "goodbye" animation. This conversation meant to be a conversation between the devices themselves, but as illustrated in the sketch before, this conversation between TOMTEs can initiate and facilitate conversation between their owners.

Feedback

During the exhibition, we got various feedback from different users. In general, people were excited to see two objects seemingly having an independent conversation and could easily grasp the concept of IR communication, easily relating this conversation to human interaction with eye contact.

One user expressed his worry on privacy matters: what if devices would share and discuss private information about their owners? From their point of view, devices with independent will could not be trusted, as they have no concept of privacy on their own. This question actually raised a philosophical debate on the nature of privacy and that different people and different cultures also have their own ideas about what is confident and what is not. Still that discussion have raised some concerns that are addressed further in this thesis.

Another user, having hearing problems, have pointed out that such conversation could help him understand that someone is trying to talk to him. For people with impaired hearing, who have to see the other person mouth in order to notice they are being called, another, visual indicator of conversation would be very helpful. They also proposed that their TOMTE could somehow indicate that they have impaired hearing, so other TOMTEs can share this information with their owners.

TOMTE-to-TOMTE communication in this thesis

There will be no other research o Reasons for that include the fact that interactions between TOMTE have been analyzed in a 2015 Keio University Graduate School of Media Design thesis by Kohsuke Maekawa, so readers who are interested in this are invited to read it. For the purposes of further third-party affective evaluation concept design, it is assumed by default that TOMTEs are able to interact and communicate with each other in a way described above, but this thesis concentrates on the interactions between a user and its TOMTE.

3.2 Ethnography

The concept by itself involves a TOMTE's owner having some sort of real life communication, that is happening at a parties or at other social gatherings or events. In order to get the idea of potential places for a fieldwork, the analysis of potential stakeholders have been conducted.

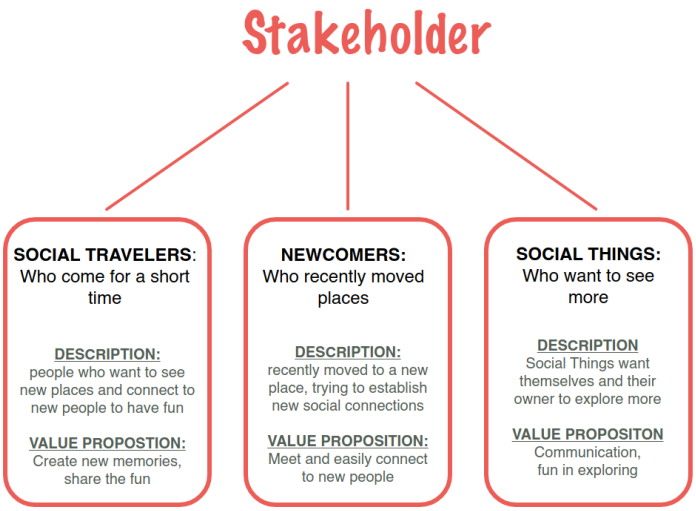

Figure 3.4: Stakeholders

Based on the stakeholder analysis, a list of potential events for the fieldwork was narrowed down to events, which might involve communication between international tourists or guests with locals and events, where newcomers, who have just recently moved to Japan, are actively trying to expand their social network. Two events have been selected: an international kimono meetup, Kimono De Jack, and a social party for exchange students, who have just arrived to Japan. Both these events represent a perfect opportunity to observe social interactions of stakeholders, to analyze their behavior and to understand their needs and wants in process.

I also have expected the potential challenges that fieldwork masters might have encountered during these fieldworks to be: a sheer number of new social connections, that is hard to memorize and manage; problem with approaching new people due to being shy or afraid to speak Japanese; inability to find common conversation topics to engage other party.

3.3 Getting new experiences in a trip

The goal of the first fieldwork was to observe a traveler with a keen and long-lasting interest in Japan, who was eager to meet and connect to new people,

despite lack of Japanese knowledge. The master, Sergey (M, 28), went to the event called "Kimono De Jack World Meetup in Tokyo" organized by Kimono De Jack community, which is an international community of people with main base in Japan, who are interested in making, wearing and promoting Japanese kimono and associated culture. Kimono De Jack is present in more than 20 countries with regular events and meet-ups happening in various cities throughout the world.

It is important to note that the fieldwork master is a part of Russian kimono community through his girlfriend, who is a passionate fan of everything kimono-related. The master himself loves to dress well and enjoys taking part in kimono shows as a model, but is not very involved with the kimono subculture per se. His visit to Japan has coincided with the event, so in order to represent the Russian community and possibly meet new people and get new impressions he had decided to attend this meetup. Being unsure if he can put on his kimono by himself, as well as having limited Japanese ability, he asked me to join him.

Fieldwork description

This meetup happened in Mitsui Hall, Nihombashi, where another kimono-related event was taking place at the same time. After arriving in the lobby, the master found himself surrounded by beautiful kimono of different types, though he had no clear idea about what exactly this kimonos represent and without understanding the full context, it was only the visuals he could really enjoy and this fact was noted and vocalized by the master.

After clarifying when and where will the event take place, Sergey has retreated in order to change into kimono. It is a process which actually requires a help of another person in order to tie the traditional Japanese belt, "obi", which is happened to be a quite tedious task of of repeating some vague instructions. After around 20 minutes of trying to tie, the master have admitted his defeat and tried to contact his girlfriend in order to get some instructions via Skype, but the connection did not allow him to do that. Japanese kimono lovers, passing nearby, gave the master emphatic looks of pity, probably remembering their own first experiences of tying this belt.

In the end, the fieldwork master has managed to tie something that looked decent enough according to his standard of obi-tying quality that has dramatically decreased after almost 40 minutes spent on that menial task. Moving into the hall, which was a room with around 100-150 local kimono fans and around 10 foreigners, out of which 6 foreigners or so were standing on the stage ready to represent and

introduce their local clubs. The master and me proceeded to seat ourselves, and as Sergey was the only Caucasian looking male wearing kimono in the room, he was greeted by happy cheers and greets from random people in the public.

Figure 3.5: First Fieldwork Master

The show has started and the master had already connected to a person seating nearby, who was a kimono lover from Hong Kong, astonished to know there is a kimono culture thriving in a faraway Russia. At the stage, the foreign participants have introduced themselves and a video with every club from around the world sharing their message about their love for kimono, appeared on the screen. Russian club also appeared there and more people in the room have started cheering the master, whom they spotted on the screen. The master was not really surprised nor frightened by the public attention, smiling and introducing himself as "that guy from Russia you just seen on the screen" in a confident voice.

The event was over in a short time, and everyone started to gather on the stage for a group photo. After they took it, crowd starting to socialize with each other, with some people approaching the master, asking for a picture together. The person from Hong Kong was the first one, but other people also approached Sergey. After taking a few more pictures, we have left the room and went to the lobby, where the socializing continued.

In order to make mementos from the meeting, the master used his smartphone to take pictures with other people too and also used an instant camera to take a few

pictures, sometimes sharing a picture with other people from a local community. The master mostly got comments on how far away his country was and on realizing that his kimono is handcrafted, other people also give compliments on how well it looks on him.

One of the local kimono lovers brought her little daughter, who was dressed in a kimono, thematically connected to Halloween, which was happening in a few days. After taking obligatory pictures together, the master talked to the girl, who also noticed that kimono looks very good and that she wants to see him again at the coming meet-ups. It was nice to see how parents bring their kids and enjoy their hobby together, helping to bond the family together.

While sitting on a bench after leaving the lobby, the master got into a conversation with two males in their thirties, who were also wearing a kimono. Again, after talking about kimonos and Russia, they took a picture with Sergey and he also took a picture with them, exchanging mementos in this way. After that they decided to connect on Facebook and added each others' profiles.

Figure 3.6: Group Picture As A Memento Of The Event

The event was over and the master decided not to change back into European clothes, deciding to stroll on Ginza in his Japanese outfit, which conveniently was also warm enough for a chilly Tokyo evening. People were definitely noticing a foreigner in kimono, and the master got some additional compliments for how good the kimono looks on him, but that goes beyond the scope of this fieldwork.

Analysis

To understand the patterns of master's interaction with other actors, the Flow Model was created based on the observations. I could clearly observe that Sergey tried his best to connect with other actors, was happy to discuss kimono or other topics even if he was not really knowledgeable about it. There is a difference in interaction between local kimono lovers and international kimono lovers, which I can attribute to the empathy that instantly appears between foreigners in Japan. Although his girlfriend was far away in Russia, Sergey tried to share the feelings of both frustration at his initial inability to tie his kimono belt and happiness at being at this event, surrounded by so many kimono lovers from all over the world. It is crucial to note that Sergey was usually the one to be approached by others and actively reacted to it, but he almost never tried to break the ice and initialize the conversation first.

The sequence of the events displays important traits of Sergey's personality. His decision to analyze and visit the venue before the event displays a certain degree of planning, which was also caused by him realizing it will take him quite some time to tie his belt, having almost no practice of doing it before. The sequence of socializing welt very natural for Sergey, who visits and attends around 10 conventions every year according to his social media page.

The Artifact Model showed that Sergey values and likes to be noticed, with both his kimono and leather jacket being highly unusual pieces of clothing, that attract public attention in both Japan and Russia. The most important object was an instant camera, which the master used to make mementos with people he have recently met. These mementos in form of instant pictures attracted was a good way to initiate or prolong the conversation and every time the other person was waiting for their picture with Sergey to appear, I could clearly observe emotional bond between the master and a person he was talking to to become deeper.

The Cultural Model demonstrates that sharing his life with friends and colleagues is important aspect of Sergey's life and a wide array of social services (Twitter, Instagram, Vkontakte) is used for this task. Being an active blogger and photographer, Sergey influences other more than he is influenced by them. At the same time, Sergey does not hide his real self from colleagues, who are following him on Twitter and read his tweets. Sergey also has deep empathy for his parents, girlfriend and even his favorite musicians and inanimate objects like trains, which he treats almost as animate objects or human beings in his Instagram uploads.

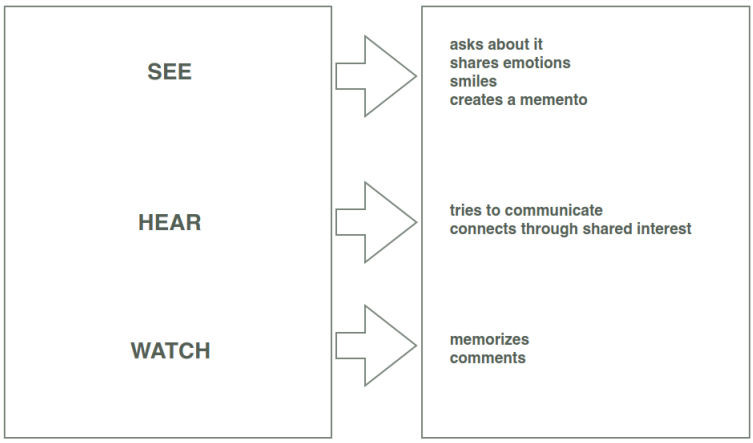

Figure 3.7: First Fieldwork Master Mental Model

Mental Model

To analyze Sergey's deep motivations, cognition and actions, the mental model that is based on the fieldwork observation was created. Sergey is actively open for new information, actively analyzing everything around himself. His curiosity manifests itself when he is asking questions in case he can not understand something. Sharing emotions or physical mementos is another key feature of Sergey's behavior. He is always open to connect on Facebook or Twitter, and happy to share a picture together - and for him this action is the way to create a physical or virtual prove of his newly established bond with another person. Sergey tries to communicate with everyone, though it does not essentially means he is approaching other people first. But if he is approached, he will always try to really connect to another person, and smile is the first step for him. In this way, he was able to make a few new connections and take a physical memento of a lot more communications, that have happened during the fieldwork.

3.4 Making new social connections at a networking event

The goal of the second fieldwork was to observe the social interactions, possible challenges and problems that an exchange student, who has recently moved to Tokyo, may encounter in process. I wanted to analyze the motivation this person

might have when approaching other people, how he ignites new social connections, finding a place for himself in a diverse international community, which usually constitutes the exchange student body in Japan. The networking event for newly selected scholarship recipients was chosen as the fieldwork location. The fieldwork master, John (M, age), has just recently moved to University of Tokyo Graduate School of Physics to study for a PhD degree in Astrophysics.

Fieldwork description

The event was organized by the Takase Scholarship Foundation, which actively tries to connect scholarship students to each other through social events and parties. It was a first event for new batch of students, so people in the room did not really know each other. To address this, Takase Foundation have asked students to send their information in advance and have prepared short pamphlets, where each student could introduce themselves and write a bit about their hobbies and study topics. The venue was on the sixth floor of the Takase Corporation headquarters in Ginze. The room was separated in two zones, with an improvised stage and chairs for coming students in the first zone and a banquet table without any chairs in another zone. There was a schedule of events, with a formal scholarship granting ceremony and self-introduction followed by a social talk time.

John arrived 15 minutes or so before the events was scheduled to begin. Leaving his belongings in a designated place, he received the introduction pamphlet and moved to his chair. For the first few minutes, he was going through the pamphlet, probably memorizing the names and faces of people, but then initiated a conversation with an exchange student from Australia seated next to him. It was a very casual conversation about weather and his university. In a few minutes, the scholarship ceremony has started.

John was closely following the speech by the foundation director, which was although given in Japanese, so he clearly could not understand that much. It was time for self-introduction after the speech and after listening to another students, John also told his name, university and degree, and told he was really honored to be at this event and was looking forward to talking to other people. A few more people have done their self-introduction after John and the event has moved into the social phase.

Everyone moved to the table, filled with different Japanese foods, took some food and have started to talk to each other. A few people from Takase Foundation, aged from 40 to 60, have also joined the party and started talking to other

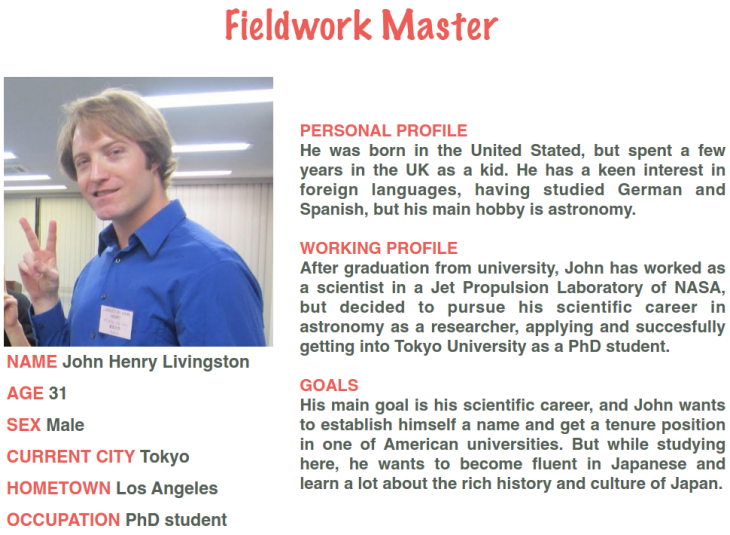

Figure 3.8: Second Fieldwork Master

students. John continued talking to the exchange student from Australia, as he could already connect to her on emotional level. Two students came to listen to their conversation, which was mostly about Johns research on discovering new exoplanets. It was definitely hard to contribute to the conversation, so it was mostly John talking about his research, while other people just passively listened to it.

In a while, the configuration of people around John changed, with a person in his 40s from Takase Foundation has approached John, asking him for his opinion about new dramatic news in American politics. Again, a few students, probably interested on what American might say about the newly elected president, so again it was mostly John talking and a group of people listening to him.

I will note a fact that John was not really eating much, spending all his time on social interaction, clearly enjoying to a good conversation he was having with other people. After a while, John managed to switch to a more casual topic and a few other students have joined the conversation.

In a bit of time, a Korean exchange student, who was actively making social contacts all over the room has approached the fieldwork master, introducing himself and sharing his business card. John did not have a business card, so he apologized for not having one.

After having a few more conversations, it was time to leave the event. John

has approached me and a few other people to exchange Line contacts, so we could stay in touch. John himself reflected on the experience as "I am sad I could not eat much, but it was to meet new people".

The patterns of John's interactions with other actors are displayed on the Flow Model in the appendix section of this thesis. From the observation I believe that main goal of the social gathering for John was to make new social connections, and his interactions mostly directed towards that goal, with him reading about the potential new connections in a pamphlet and using iPhone only for Line exchange. John did not even eat that much and was mostly holding a beer glass during the whole evening.

Sequence Model shows a very typical social gathering event and John, brought up and raised in western culture of networking parties felt very natural in it. John is used to talk about his studies and research to other people, and he knows how to talk interestingly about it, which is probably caused by the fact he has to work as a teaching assistant for some classes in his university. Artifact Model again displays a very typical set of artifacts for a social event.

Cultural Model displays the importance of his work and research for the field-work master. He stays in touch and even collaborates with his former colleagues and although science is his main trigger for staying in touch with his colleagues, these social connections from his previous work and university are not cut, but being passionately maintained. Being a part of NASA in the past defines John's in the eyes of others and although he mentions it very subtly, it changes his perception in the eyes of others. Line and Facebook are the two main social network he uses, and he sees using Line as being natural for a person staying in Japan, so he uses it as his primarily way to exchange contacts. He actively tries to connect with other people, though conversation in a lot of cases turns into him giving monologues, he seems to be used to it.

Mental Model

Mental Model, an abstract description of John's deep behavior and thought process was constructed. Connecting to other people is one of the deepest motivations that I have observed. John does his research before meeting someone, but he knows that he is interesting enough to be approached by people and always ready to have a good conversation. He is not afraid and probably even enjoys the moments when his conversation turns from a dialogue into a monologue and another conversation partners seem to enjoy it, giving insightful questions for him

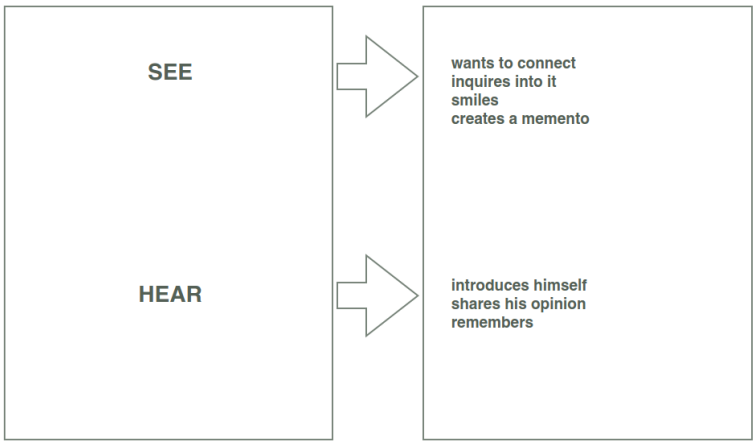

Figure 3.9: Second Fieldwork Master Mental Model

to continue. Still that does not mean he is not knowledgeable of the basic social norms - he always smiles and ready to listen to other person if that other person have something to say. For John, having artifacts of conversation is very important, and in his case new entries in his Line friend roster plays that role.

3.5 Target persona

After the ethnography was finished and analyzed, two target personas based on the initial stakeholders have been created. These target personas are the ideal representations of values, behaviors and patterns identified in the fieldwork. I see these target personas as the first and most active users of TOMTE, though of course userbase is not limited by these two types. Still, there is a number of traits and behavioral similarities that are shared by these target personas that I want to emphasize.

- **Making an artifact of social connections:** For target personas it is crucially important to have a certain proof, certain object be it virtual or real that their interaction has succeeded and that they have made a new social connection.

- **Ice breaking:** Breaking the ice is very important for target personas. Not knowing a lot of people at the social gathering, but actively willing to share

and expand their social network, target personas sometimes have difficulties in breaking the ice, though this can be mitigated by preparation or circumstances of a social event.

- **Expanding their social network:** Target personas are "hungry" for new social connections, because for them expanding their social network is the way to enrich their local experience and get new opportunities, from having a good meal to a new career pathway.

Social traveler

Michael Kursh is a Python Developer, living and working in a mid-size tech enterprise in Moscow. Michael leads a team of few people, but he combines managing others with assigning challenging programming tasks for himself. Michael loves traveling to different countries and knows where to go, by connecting to new people through Twitter and local tech meetups. He wants to eventually start up his own business and does not think that he is limited only by Moscow, thus any potential contact abroad may bring him closer to his dream. He usually does not approach people first, unconsciously unsure of his own English abilities, but in fact he knows how to hold a decent conversation. Facebook is his main social networks and when he exchanges contacts, he usually shares his Facebook and profile with another person.

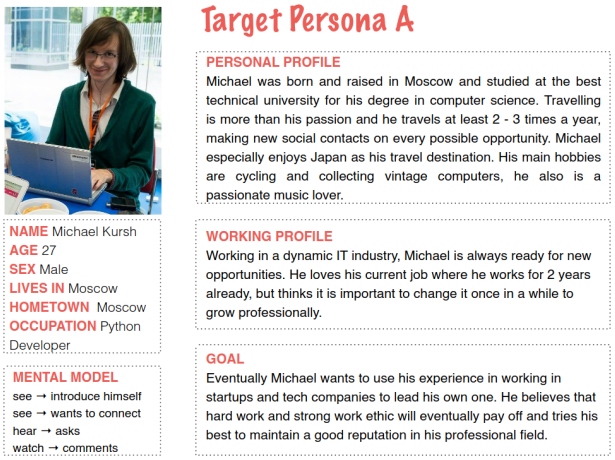

Figure 3.10: Social Traveler Target Persona

Recent newcomer

Yuri Sangomov is also a Python developer, who just moved to Tokyo to work for a startup, which is founded and supported by Microsoft Japan. Yuri is completely satisfied with his job, so his main goals for his new life in Tokyo are to improve his Japanese and meet new people. He actively goes to different startup and developer meetups, and always joins when his other friends invite him to go somewhere. Yuri uses Facebook but not very actively and prefers to exchange contacts using Line.

Figure 3.11: Recent Newcomer Persona

3.6 Design concept

Concept building

After analyzing the fieldwork data and doing the literature review and review of related works, the TOMTE concept have been finalized. TOMTE joins its user for a social party or a networking event, observes its owner interactions, performing third-party affective evaluation, analyzes the data and shares its opinion, encouraging user to continue communicating and creating another virtual artifact of communication. Using the medium of physical interactions, TOMTE displays the distance between the partners in a non-intrusive way, or becomes a topic of conversation for ice breaking, improving the overall communication experience.

In order to realize all the mentioned goals, three layers of the prototype have been proposed. The relation between the layers is displayed on the figure below.

- **Physical layer:** It is the physical prototype itself, which gathers raw interaction data for analysis using sensors and performs physical interactions with the user and other people.
- **Data layer:** This layer analyzes the raw data from sensors, sending interpreted results to the physical layer for subsequent interactions and to the application layer.
- **Application layer:** It is the application where interaction between user and TOMTE happens. In order to interact, interpreted data from the data layer is used.

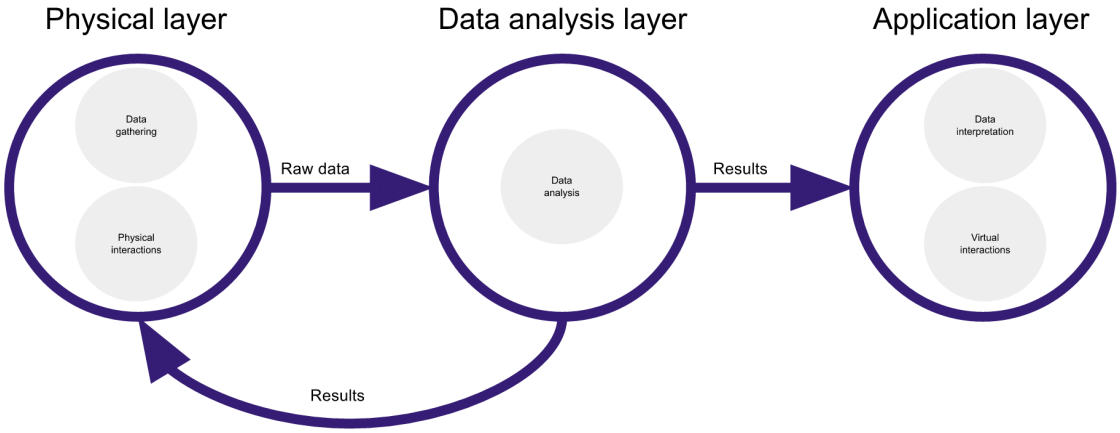

Figure 3.12: Three Concept Layers

Scenario of TOMTE usage

To visualize and describe the concept from a storytelling perspective, a following usage scenario is proposed. It employs a previously described target perosna of social traveler, Michael Kursh, who have arrived to Japan, Tokyo and decides to visit a local Python software engineers meet-up he heard about from his friend.

Arriving to the venue, which is a co-working space, Michael sees around 40 people. The party has already started, so people are forming small groups, interacting with each other and discussing various topics. Michael has his TOMTE attached to his shirt and activates the "interaction mode", so TOMTE is ready to observe and register conversations of Michael.

Michael approaches Takuya, a local Python and tries to introduce himself to Takuya in English. Takuya does not speak English really well, and although he introduces himself and asks Michael about the weather, the conversation does not really proceeds beyond that. Takuya smiles, apologizes and retreats. TOMTE notices it was a very short conversation and ended much faster than Michael's average interaction, so it assumes it was not a good conversation. Michael feels that maybe this is not the right place for him to be, and decides to walk around the room and maybe grab something to eat.

5 minutes or so have passed, but Michael is still hesitant to approach new people after his initial failure. A notification from TOMTE arrives to his iPhone. TOMTE tells Michael not to give up and try to tell to other people, mentioning TOMTE himself did not like the previous persona at all. After reading it, Michael smiles and decides to try his luck again.

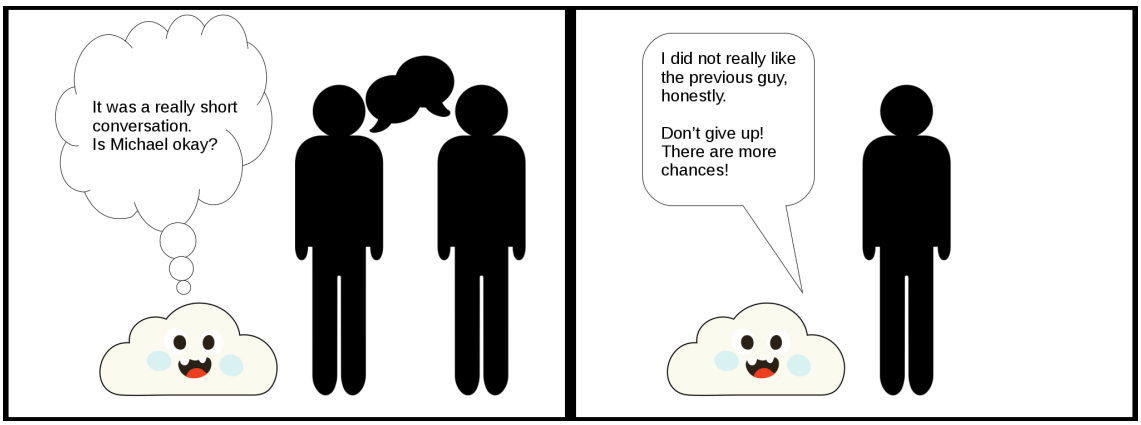

Figure 3.13: Encouragement after bad conversation

He notices and approaches Peter, who is a German software engineer, working in Tokyo. They are having a good conversation for 5 minutes or so, discussing professional topics and exchange the contacts afterwards on Facebook. Connected to Michael's Facebook, TOMTE gets the information about new contact named Peter and assumes a conversation that has just happened was between Michael

and Peter.

Michael notices another person with TOMTE, Kazuya and approaches him, jokingly saying that "My TOMTE has noticed a friend in the room" and introduces himself. While they are having a conversation, their TOMTE also have a conversation, exchanging names of their owners. Michael and Kazuya are situated really close to each other on a distance that is closer than Michael's average distance, but user's heart-rate is around its average values, so TOMTE assumes it is a good, enjoyable conversation.

After a short break, Michael talks to Miyo, who notices his TOMTE and asks about his experiences. Michael gets a bit nervous when Miyo gets closer to get a better look at his TOMTE, but when she steps backs he feels pretty good. TOMTE notices this interaction from his distance sensor and takes a note about it.

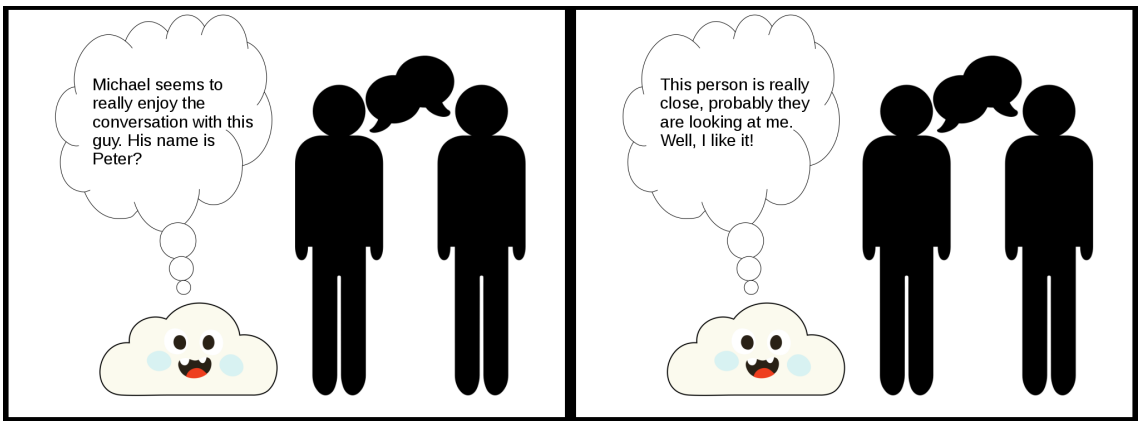

Figure 3.14: Third-party affective evaluation in process

Michael is having his final conversation with Martin, another developer located in Japan. Martin consistently stays at a distance from Michael and although they are having a long 4-minute conversation, there is not any real wish to connect from either of them. TOMTE notices this and rates the conversation as an average one.

Michael wants to leave a party and deactivates the "interaction mode". TOMTE instantly sends a notification to Michael, saying that he really liked Peter. The person after Kazuya also caught TOMTE's attention, because they seem to like him. Michael realizes he did not get Miyo's contacts and approaches her again before leaving, saying that his TOMTE thanks Miyo for being interested in it, asks for her Facebook and gets it.

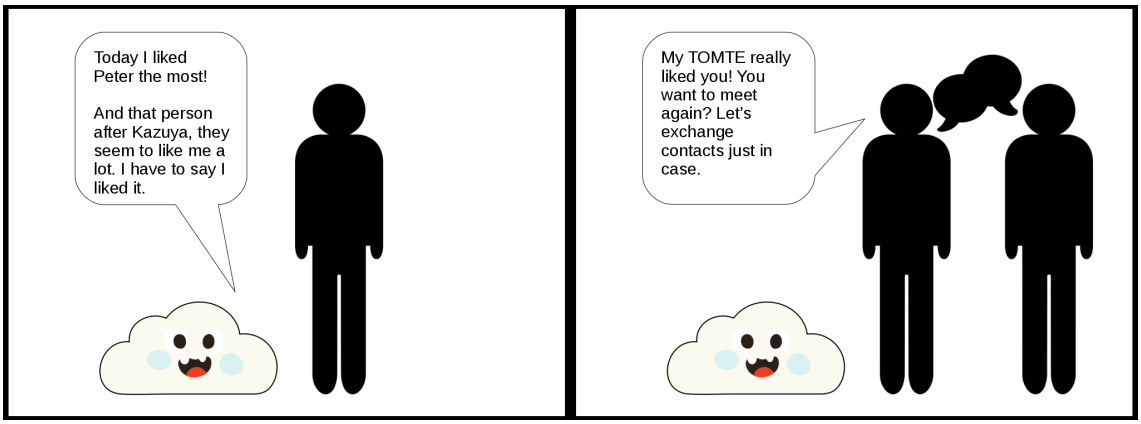

Figure 3.15: Interaction after a social gathering

Physical layer

To design the physical prototype itself, four main points of the potential TOMTE physical prototype have been defined:

- **Make TOMTE a good observer:** To perform third-party affective evaluation, logging distance data and heart-rate data with high precision and frequency is crucially important.
- **Make TOMTE easy to relate:** It was decided that TOMTE should be clearly seen as part of conversation, not just as a device, but as a pet or a friend, who is listening to a conversation and sometimes takes part.
- **Make TOMTE interactive:** Three interactions to be programmed into TOMTE: interaction to indicate and show when a conversation partner is in owner's intimate zone (50 cm. or less), interaction to remind another person that he is being observed by TOMTE and interaction to physically display that TOMTE is not observing anything right now.
- **Help TOMTE recognize conversations:** A button to be installed into TOMTE to change between different modes: interaction mode when his master is talking to someone and no-interaction mode when his master is not having a conversation.

Physical prototype was designed using Arduino and compatible sensors. It captures data from two main data streams using HC-SR04 Arduino ultrasound

distance sensor and Fitbit Charge HR, saving distance data on SD card and heart-rate data on FitBit. In order to log data with a timestamp, a real time clock (RTC) module for Arduino was additionally used.

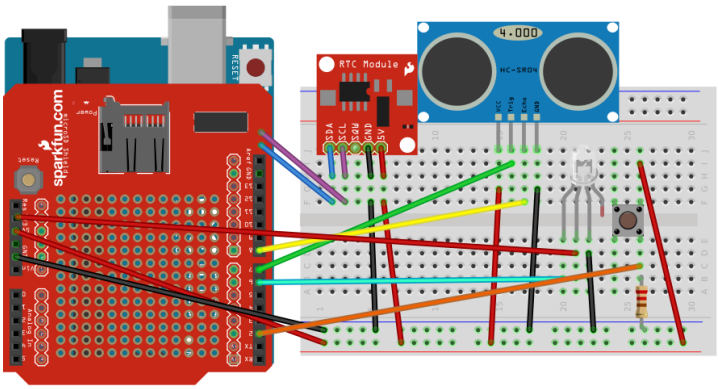

Figure 3.16: Breadboard scheme of the physical prototype

To make prototype easy to relate and not to be perceived as a wooden box with sensors and LED, I tried to design physical prototype's front to look like a face, which sends across a message of TOMTE being almost alive.

Previously described interactions are displayed on the TOMTE's "nose", which has a LED inside. Three interactions have been programmed into the prototype. The interactions are described in the figure below:

The prototype is moderately portable and powered by a portable battery. In order to have access to the SD card inside, the left side of the prototype was made removable and is attached using magnets.

Data analysis layer

Data analysis layer analyzes the interaction data and sends analyzed results either to physical layer or to application layer. The raw interaction data from the sensor is recorded in the following structure: "date; time; distance in centimeters" and saved to log file on the SD card. On average, there are 4 distance values per every second.

Fitbit Charge HR saves the data internally and in order to access and use it, the psFitb1t library by Collin Chaffin[1] has been used. It extracts daily or monthly heart-rate data in .csv format and data has the following structure: "time; distance

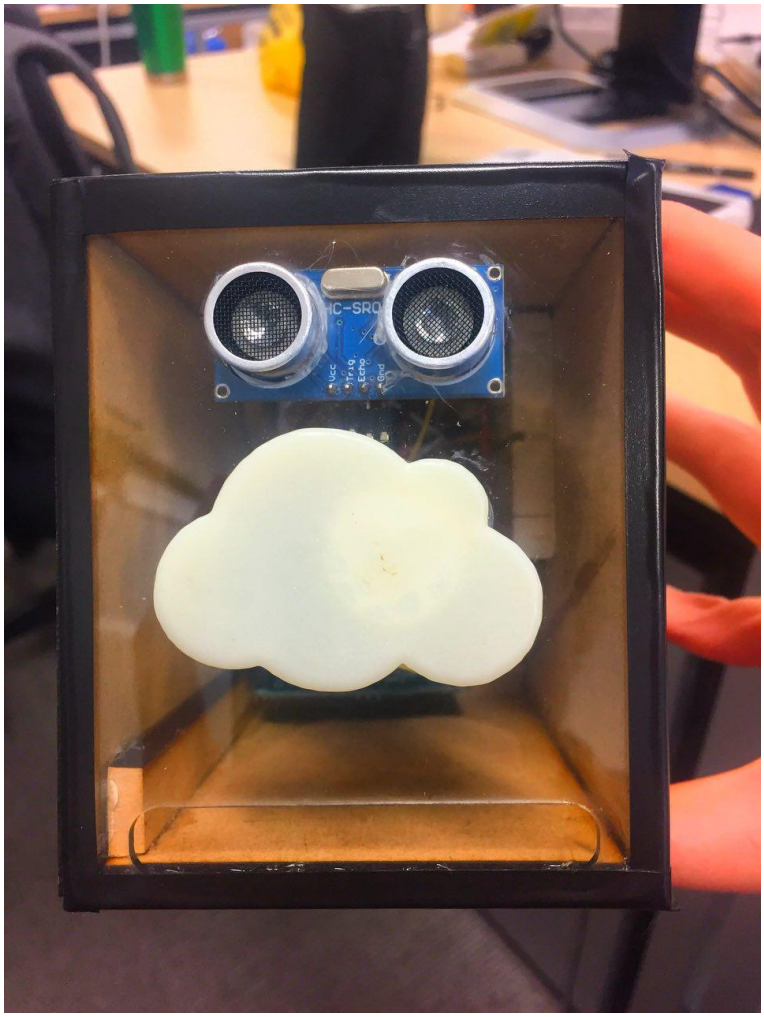

Figure 3.17: Front view of the physical prototype

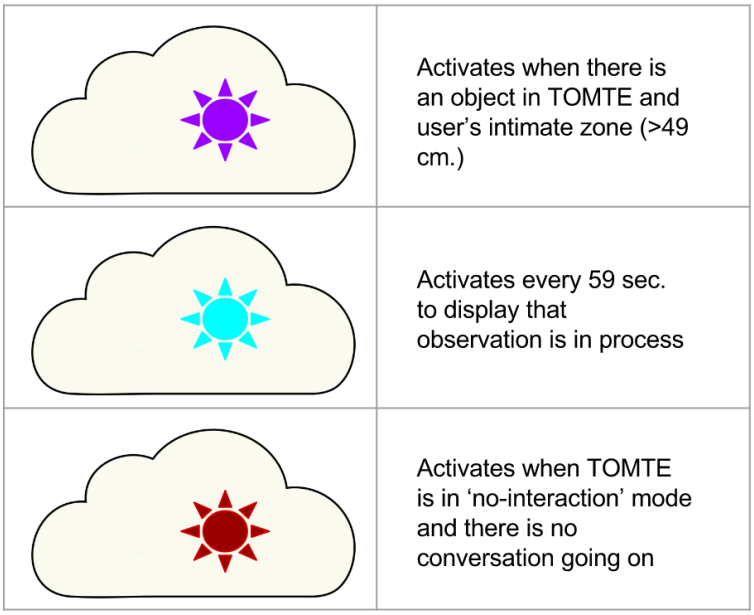

Figure 3.18: Physcial prototype interactions with LED

in centimeters; date". Fitbit is a commerical product, so the raw data was found to be very clean and reliable.

The first LED interaction, with LED displaying pink color when there is an object in TOMTE's or user's intimate zone (less than 49 cm.) which was described above, is an example of connection between physical layer and data analysis layer. This interaction depends on the raw data from the distance sensor and realized on the software level in the Arduino prototype code. The data analysis logic is displayed below.

```
if (1 < uS && uS < 49 ) { //when distance is less than 49 cm
     strip.setPixelColor(0, strip.Color(30, 0, 30));
     strip.show();
     } //this is where the interaction happens
```

In order to simulate connection of data analysis layer with application layer, thorough data analysis was required. It was quickly found that this analysis takes more computing power than available on Arduino and needed complex mathematical approach.

In a process of testing the prototype and looking at the raw data from distance sensor, it was discovered that data requires a lot of work in order to be cleaned

and used for calculations, as the sensor was not reliable enough. The example of raw data can be seen in a figure below, with typical problems and solutions being the following:

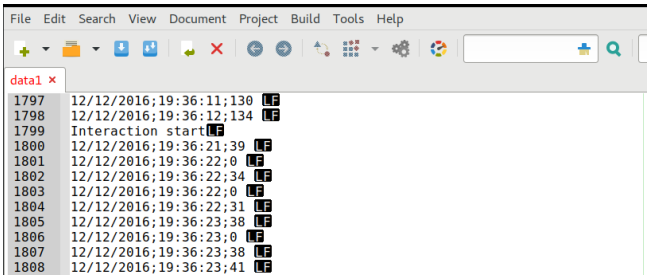

Figure 3.19: Raw distance sensor data

- **'0' cm distance data:** Checked the values, discarding unrealistically low (less than 10 cm) or unrealistically high (more than 300 cm) distance values
- **Unrealistic interactions, change of distance for 40 cm or more in one second:** Check the values, comparing to neighboring values, locating and eliminating unrealistic changes in distance.

After cleaning the data, distance data from a distance sensor and heart-rate data from Fitbit Charge HR can be merged into a single processed data file, which has the following structure: "time (in sec.); distance (in cm); heart-rate (in BPM); label (number of the interaction)". The detailed example of interaction data analysis from a networking event will be described in the "Prototype Test" section.

Application layer

Application layer is where the interactions between a user and TOMTE happen. After analyzing and processing the data from a social interaction that it received from the data analysis layer, TOMTE might bring up its opinion to user, especially when it notices that user is not having a conversation right now and not busy or when user leaves a networking event, making an improvised report, creating additional artifacts of communication.

For an application layer prototype, a new account in Telegram, one of the most popular mobile messaging apps in Russia, was registered. Having TOMTE

as friend in your Telegram roster helps to relate more: it is one of your friends, who sometimes messages you in a messaging app. A target personas conceived earlier frequently use such messaging apps, so the usage flow should be a well established part of their mental model. All interactions with TOMTE for a prototype test and validation have been simulated through this application.

At the figure below, a contact list with TOMTE is displayed on the left screenshot. In the screenshot in center there is example of notification from TOMTE. Finally, the right screenshot represents an example of conversation between user and TOMTE.

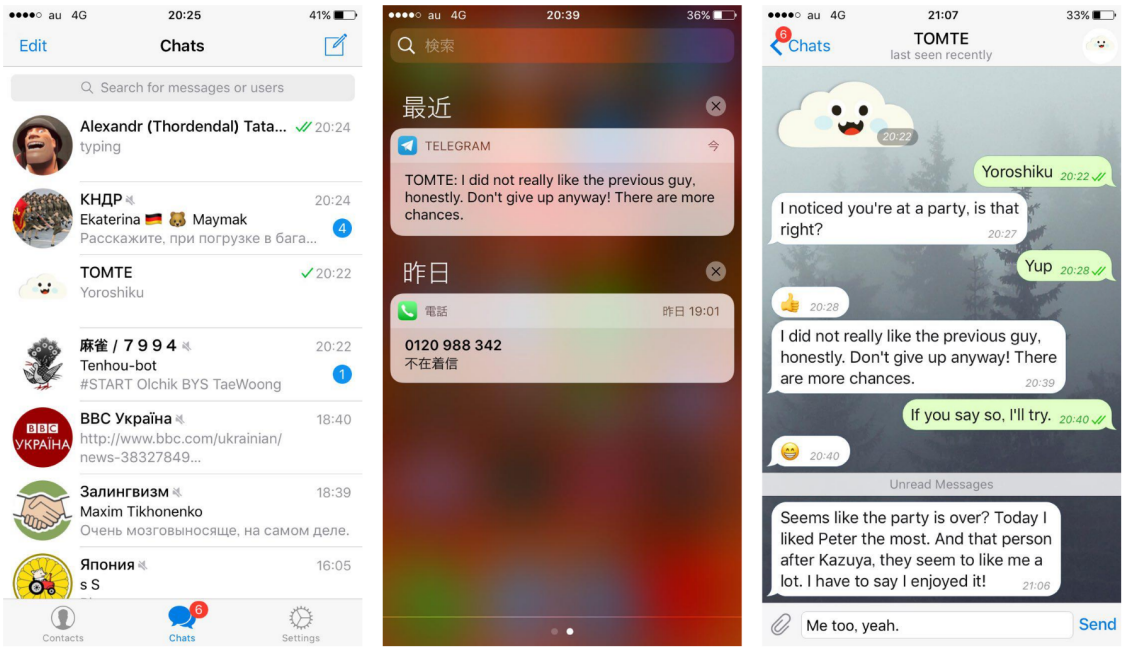

Figure 3.20: Application layer prototype

3.7 Prototype test

In order to get feedback for TOMTE in a situation of a real social gathering, get conversation data and see which information can be acquired from it and test prototype's ice-breaking value, a prototype test have been performed at a party. The venue for the party was an Anglican Christ Church in Yokohama, where a special evening Advent service and a social party afterwards happens every year.

This service has a much bigger attendance than a usual Sunday morning church service with around 100 people present, out of which around 60 people or so stayed for the party, which started from 18:30 and lasted for 1 hour. I want to kindly thank the pastor, Fr. Andrew Dangerfield, for giving permission to conduct the prototype test. People at the party neither knew about the test nor saw the TOMTE prototype prior to it.

Figure 3.21: Prototype test at Christ Church, Yokohama

Test flow and general data analysis

This prototype testing had the thesis author himself (male, 27 years old) as the test user. During the test, the user was behaving in his usual manner, holding a prototype in his left hand. He have never met most of the people in the room, with most of interactions happening with a people he saw for the first time. In duration of 30 minutes, when the prototype test was conducted, he had interacted with 7 people and got reliable data for 5 interactions, which will be described below in detail.

The raw sensor data have been cleaned and processed afterwards in a way described in "Application layer" section. For analysis, iPython notebook and *matplotlib*, *pandas* and *numpy* libraries have been employed.

Interactions with 5 following people have been recorded: Chieko, Laura, John, Andrew and Alice (for purposes of anonymity, the names are changed). To see

the overall picture, a table containing mean data of BPM and distance during all the interactions, minimum and maximum values was arranged.

Table 3.1: Avaerage data of all interactions

-	Distance, cm.	Heart-rate, BPM
Mean value	99.95	78
Min value	24	74
Max value	208	88

Analyzing this table, it is interesting to note that mean distance for a social interaction for the user is almost exactly 1 meter, though it varies greatly during the interactions. BPM stayed relatively stable during all the interactions, showing only a moderate change. This value represents only a mean value during the interactions, so it should be compared with a mean BPM value during the evening (from 18:30 to 19:30) to be more representative. The mean value for the evening is 84.8602150538, which means that user was more relaxed than usual during recorded conversations. It might be also related to the fact that user was not actively moving when having a conversation.

To visually compare the overall conversation data, two graphs which illustrate the changes in heart-rate and distance during the interactions have been plotted.

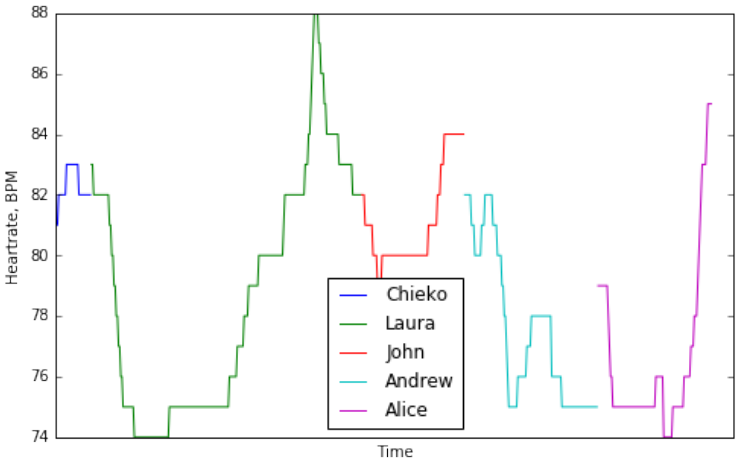

Figure 3.22: Heart-rate in all recorded interactions

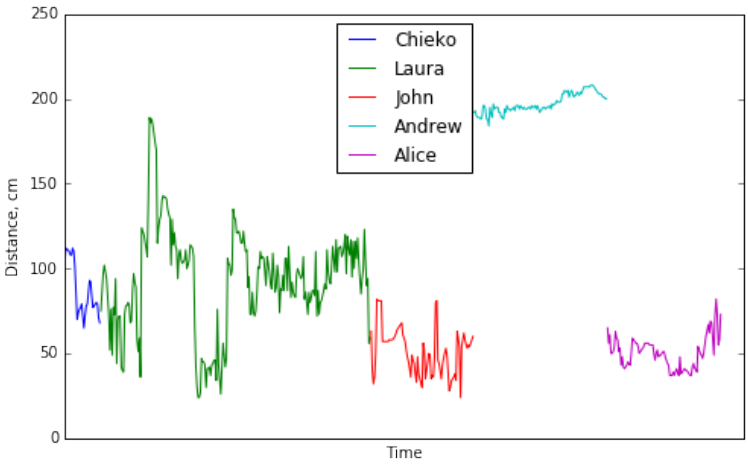

Figure 3.23: Distance in all recorded interactions

By looking at the first graph, we can see that conversation with Laura had the biggest variation in BPM. Conversation with Chieko, being really short, has the lowest variation, followed by conversation with John. Second graph which displays the distance shows that conversation with Andrew has almost no variation, at the same time, compared to other four conversations, the conversation with Andrew had the biggest social interaction distance. In conversation with John the social interaction distance was consistently less than mean interaction distance, which might indicate that user already knows John.

To visualize the distribution of conversations in the user's personal space, a density plot was plotted. We clearly can observe two peaks at around 55 cm., representing majority of conversations, which happened in user's personal interaction zone and another peak around 200 cm., which shows a conversation, that happened it user's social interaction zone.

Distance and BPM have been checked for correlation, but no association between these two values was detected. As the user's BPM did not fluctuate much during the prototype test and no conversation did any intrusion into user's intimate space for a long time, this result was expected.

In the following table 3.2. *Comparison of interactions*, we can observe the difference between conversations in detail. Each conversation has its length data, mean, maximum and minimum distance and heart-rate compared. In addition, "Met before" row shows if user has ever met a conversation partner or not. A subjective evaluation of conversation in scale from A (the best) to F (the worst)

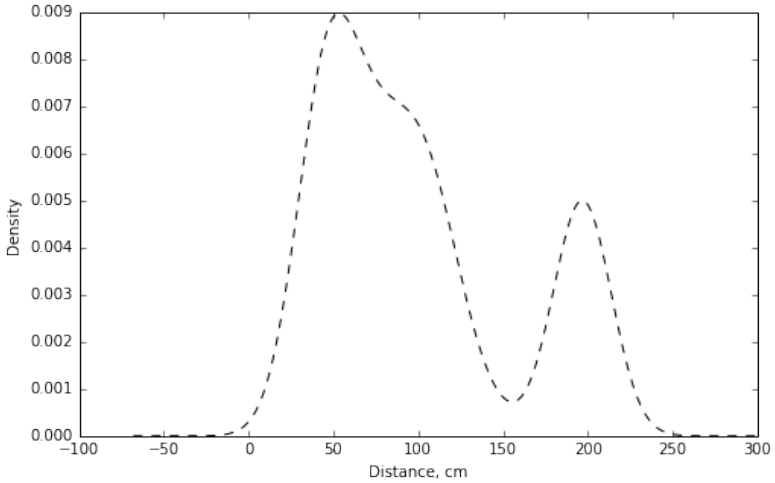

Figure 3.24: Density plot of distance data

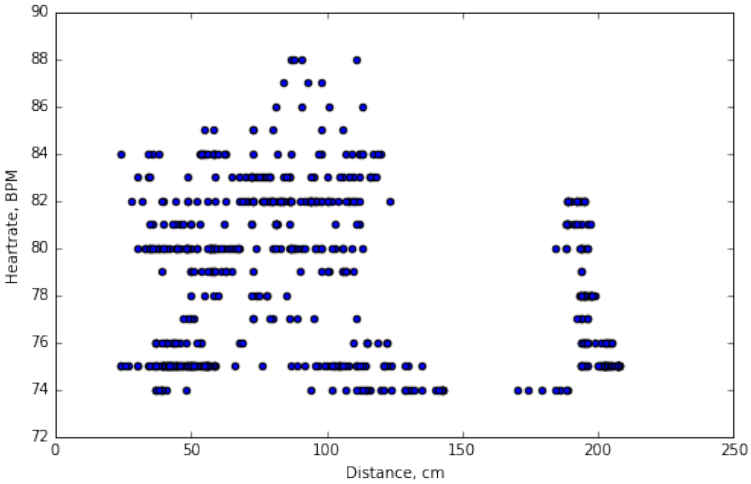

Figure 3.25: Scatter plot for correlation between heart-rate and distance

is also shown.

Table 3.2: Comparison of interactions

-	Chieko	Laura	John	Andrew	Alice	AVG.
Length (in sec.)	32	239	91	118	101	116.2
Mean distance (in cm.)	87.5	93.1	51.1	197.3	50.4	100
Max distance (in cm.)	112	189	82	208	82	208
Min distance (in cm.)	65	24	24	184	37	24
Mean heart-rate (in BPM)	82.25	78.72	81.14	77.52	76.64	78.69
Max heart-rate (in BPM)	83	88	84	82	85	88
Min heart-rate (in BPM)	82	74	79	75	74	74
Met before	N	N	N	Y	N	-
User evaluation	F	B	A	B	B	-

Evaluation of each conversation and possible feedback by TOMTE

Based on analysis of every interaction data using this table, we can design possible interactions with user in the application layer and give reason for such decision by TOMTE:

Chieko: conversation with Chieko is considerably shorter than an average conversation, while heart-rate is higher than average, so TOMTE might assume that was a failed conversation. In this case TOMTE can encourage user if there is no interaction happening in 3 - 5 minute after this failed attempt.

Laura: conversation with Laura is longer than usual and has a mean distance and mean heart-rate close to the average value. At some point the distance changed to 24 cm., which represents the moment when Laura got really close to TOMTE in attempt to interact with it. TOMTE can say it really liked or enjoyed interacting with Laura.

John: conversation with John has the mean distance that was well below average. At the same time, user did had a heart-rate that was higher than average, which might represent a wide array of emotional reaction from happy agitation to discomfort. TOMTE can say that it remembered this interaction, because John was staying really close.

Andrew: conversation with Andrew has the distance value almost two times higher than an average conversation, which shifts this interaction from user's personal interaction zone to user's social interaction zone. TOMTE will probably have nothing to say on this conversation, assuming that user was not really involved or connected.

Alice: conversation with Alice also has a very close distance between the user and Alice. At the same time, there are no big fluctuations in heart-rate and it is below average. TOMTE can say that it liked this conversation the best, because it seems like user was involved the most and enjoyed it the most from the data.

Data analysis layer prototype limitation

The explanation and flow of data analysis that is displayed above is of course limited by the fact that the dataset is very limited. It is assumed that TOMTE gets more data and learns more and more about its user with every party and every interaction. To rephrase, with increased amount of stored data, the recognition of interactions gets extensively better and precise. Still the author believes that the overall flow of data analysis will remain the same.

Feedback on the physical prototype

During the prototype test, every conversation partner asked about TOMTE and what it does, which proves "ice-breaking" value of TOMTE. Out of all 5 users, Laura was the only one who had a passionate conversation with TOMTE itself, calling it "a cute little thing" and waving hands in front of it to observe the LED interaction. This interaction can be noticed in her distance data above. As a topic, TOMTE played a major role in conversation with Laura and John, played a minor role in conversation with Andrew and was only briefly discussed in conversation with Alice.

Notes

1 https://github.com/CollinChaffin/psFitb1t

Chapter 4
Validation

4.1 Structure of validation

To understand, validate and confirm whether the physical and application prototypes described in the previous chapter have fulfilled its design goals, a user evaluation consisting of three parts have been concluded. The evaluation consists of four in-depth interviews of users aged from 24 to 43.

The users first have been asked a pre-test survey questions, which are listed in Appendix B. of this thesis in order to understand their background, usual behavior in social setting and find out if they have any commonalities with target personas or not.

After that interaction test has been performed. Before the test, the personal interaction space for each user was measured and clarified. Users have been asked to share their opinion on TOMTE physical prototype, compare it to something to check if the physical prototype achieved a goal of stated during design process of being easy to relate.

In next part of the interaction test, intrusion into each user's intimate distance zone have been performed, while they have been holding the TOMTE physical prototype in order to find out their reactions, understand if they share their personal space with their TOMTE or see it as having it's own personal space.

Finally, after interacting and understanding the TOMTE concept, users took part in a scenario test, where they have been directed through the scenario described in Chapter 3.8., with script being adjusted for each user's personal circumstances a bit. While going through the scenario, interactions between TOMTE and user have been simulated with the application concept also described in Chapter 3.8.

4.2 Validation tests

User J

Figure 4.1: User J

Pre-test

User J is a 24 year old female, born in Taiwan, staying in Japan as a student for past two years. She noticed that her friends circles got smaller after moving to Japan, so she actively tries to get new connection, going to a parties once or twice a month with a particular goal to meet new people. She finds it hard to approach people at such parties, so prefers to come with a friend, to whom she might talk at first. When she approaches new people, she really does not have any specific phrases or lines and usually casually introduces herself.

If she gets interested in a person, she might ask for his or her Facebook contacts right after a conversation. She will never add a suggested friend if she has not met them in a real life before.

Interaction test

Personal space have been analyzed for user J. 120 cm. feels to be too far away for her, she feels comfortable from 110 cm., and around 60 cm. is still acceptable, but less than 60 cm. feel too intrusive. When another person intrudes into her intimate distance zone to speak to her TOMTE, she still feels that to be very intrusive.

When she sees the TOMTE's nose changing color to pink she asked about the interaction and realized it is related with intrusion into her personal space. She could easily identify a face in TOMTE, though when an LED was blinking she was looking at TOMTE's "nose" instead of its "eyes".

She wants TOMTE to has more interactions related to the personal zone intrusion, because it is hard to see the LED when the prototype. She proposed to put a vibration motor inside and use vibration for possible other interactions.

Scenario test

While going through the scenario test, she positively said that encouragement by TOMTE after a failed social interaction will give her a push. She almost feels that with TOMTE she is having a friend she knows well at a party. She will use her TOMTE as a conversation topic and will share with other person that her TOMTE liked them.

User M

Pre-test

User M is a 43 year old male, born in the United States, who is consequently living in Japan for last 16 years. He described himself as a teacher at heart and a businessman. His social circles in Japan are actually bigger than back in the States, so he never goes to a party with a sole purpose of meeting new people. At the same time he feels that the quality of his social circles is a bit worse here than back in the States. When approaching new people a party, user M has no specific prepared lines and stays himself. Yet he always observes the body language and generally observes a person who through various social clues (eye contact, smile, body language) is displaying that they are open for conversation.

He rarely asks another people for their Facebook contacts if he is interested in them, but he sometimes exchanges Line contacts. He will never add a suggested

Figure 4.2: User M

friend on Facebook or other social networking service if he has not met them before.

Interaction test

Personal space have been analyzed for user M: 120 cm. feels to be almost okay, but a little bit far. Distance from 100 cm. to 45 cm. is perfectly fine for user M, but closer distance feels uncomfortable. When another person intrudes to speak to his TOMTE he feels fine with it: he perceives TOMTE as having it's own personal space.

User M really liked how TOMTE looks like and interacted a lot with it almost as if he would interact with a pet. He could clearly see the face and mentioned that TOMTE looks very alive to him. Out of all the users interviewed, user M definitely interacted the most with a physical prototype.

Scenario test

User M probably will not lose that much confidence after a failed social interaction, but still he might feel a bit encouraged after getting a message from TOMTE. He

will not mention that his TOMTE liked another person in a conversation because it might feel too weird. For him, the possibility to get reminded about good interaction seem to be a good feature and he compared having TOMTE with having a personal assistant alongside you at a social event.

User K

Figure 4.3: User K

Pre-test

User K is a 25 year old female, born in China, who lives in Japan for last 2 years. She is a student. Her social circles in Japan are bigger compared with China, because she did a lot of part-time jobs, making a lot of connections in process. User K described herself as very passive and *desocial* person. She never goes to a social interaction specifically to meet new people, but she has a social parties at her current part-time job maybe once or twice a month. She never approaches anyone at such parties, usually staying in a corner, slowly creeping into other person's personal space, hoping to be approached by another person.

She never asks people for their Facebook contact after a conversation, but adds them later through their common friends. This also gives her a chance to remind them about a conversation they had before. She will never add a person from a suggested friend list if she have not met them before for one or two times.

Interaction test

Personal space have been analyzed for user K. 120 cm. feels to be too distant, but the distance from 100 cm. to 60 cm. feels good, with 60 cm. as the very best distance. At the same time, user K reacted strongly to the conversation distance being less than 50 cm., almost instinctively taking a step back. Out of all the users tested, she has the strongest reaction for intrusion into her intimate distance zone.

Figure 4.4: User K strongly reacting to uncomfortable distance

User K could clearly see a face in the prototype, a face with a shiny nose. She feels when someone else is holding TOMTE, a user and TOMTE feel like one entity, which shows she could not fully see TOMTE as a separate actor. When another person tries to interact with TOMTE it feels very intrusive to user K, so she put it forward holding TOMTE in both hands.

Scenario test

User K will definitely be demotivated after a failed interaction. She will really like the fact that her TOMTE also did not like another guy and will probably want to reply to TOMTE and converse a bit. But user K hates to be encouraged, so she will not enjoy if her TOMTE will try to push her to talk to more people. If after a party TOMTE will like the same person as user K did, she will feel that her TOMTE is really smart. At the same time, she will feel that this might be a bit unsecure. User K has no problem with sharing information that her TOMTE liked someone if she remembers them interacting with her TOMTE.

User S

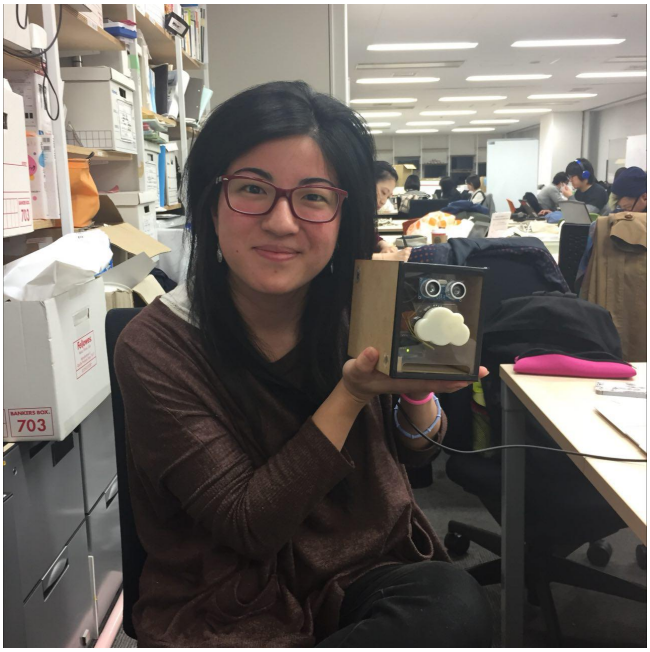

Figure 4.5: User S

Pre-test

User S is a 28 year old female from Argentina. She lives in Japan for 3 months already and is a student. She thinks that amount of her social connections did not change that much after moving to Japan, because she met a lot of new people

at her university. She does not go to parties with a specific goal to expand her connections, but will go if her friend is inviting her. It depends on the situation and person, but she sees herself actively approaching other people. She usually thinks of a certain line or a way to start conversation.

User S feels okay to exchange Facebook contacts right after a conversation. She never adds people she have not met earlier from her "Suggested Friends" list on Facebook.

Interaction test

Personal space have been analyzed for user M. 120 cm. is too far for her, but distance from 90 cm. starts feeling okay. 60 cm. is totally fine for her and even a distance of 45 cm. seem to be okay for her, which might be caused by social interaction customs existing in Argentina.

She could see a face in the physical prototype and said it looks like a cartoon sheep. She understood the interaction that makes LED blink, but noticed it is hard to observe when you are holding a TOMTE directed at your conversation partner.

Scenario test

User S laughed a lot when she read simulated messages from TOMTE. She will strongly see TOMTE as her friend and will want to have a further conversation with it, specifically after a failed conversation. She sees no problem in sharing the information that her TOMTE liked someone with them and sees it as a good conversation topic or conversation starter.

4.3 Discussion and improvement

Checking the design goals for creating a physical prototype stated in Chapter 3.8. with all the feedback acquired during the prototype test and concept validation, the following could be stated:

- **Make TOMTE a good observer:** There is no problems with getting the heart-rate data, but distance data gathering can be possibly improved by adding another distance sensor and comparing the data between these two sensors. At the same time, this improvement can not interfere with the next point.

- **Make TOMTE easy to relate:** I believe this goal was achieved. Everyone saw TOMTE as having a face and its own personal character, and the only variation in perception is related to completely separating TOMTE with its owner or perceiving these two as a single object.

- **Make TOMTE interactive:** This point can be improved on by adding a vibration motor, so the interactions can be also felt by a user holding TOMTE prototype.

- **Help TOMTE recognize conversations:** There were no problems with this function, though it was mostly reserved for technical use in order to make sure the gathered data is properly marked.

TOMTE could validate its value as a conversation starter and a good topic for "ice breaking" in a conversation. Different users have different views on sharing the information TOMTE tells them with other people, but every user tested enjoys the idea of having TOMTE at a social interacting, comparing it to friend or a personal assistant.

Chapter 5
Conclusion

5.1 Overview and findings

The third-party affective evaluation design concept, realized in a form of TOMTE, a prototype consisting of three layers, aims to propose a new type of Social Thing device. TOMTE has all the traits of a Social Thing: it is equal to humans and even perceived as a friend or another conversation party. It has the ability to learn and with every new interaction and a party TOMTE gets to know its user better, more deeply understanding their bio-metrical data and behavioral patterns. Finally, the cooperation with other things have not been covered in the scope of this study, but author sees no limitations for such interactions other than security concerns for the user data.

TOMTE is an affective, emotional device. It gives emotional feedback on other people but also ready for an affectionate interaction from its user's conversation partner. TOMTE interacts when someone intrudes his and his user's intimate conversation zone and although there are varying interpretations of this interaction, it is seen as emotionally-driven as much as it is data-driven.TOMTE also tries to encourage users to be more social if they need some help and encouragement, hopefully making new contacts in a real life, thus expanding their own physical social network.

Author's personal experience might be perceived as biased, but every interaction I had so far involved people either asking about TOMTE right from the spot or during the conversation, which indicate that it perfectly asks as a conversation topic and a reason to start a conversation. This might change when a novelty effect runs off, but TOMTE might also change and learn a lot by that time.

5.2 Future works

In order to prototype the concept, a number of compromises have been made: I had to limit physical prototype with only two data streams, which proved to be the most reliable, though of course connecting TOMTE to more data streams, including voice, eye-gaze, breathing and other data if there is reliable and cheap way to get good data that can be analyzed.

Scope of TOMTE's usage can be extended to other settings where third-party affective evaluation is possible: business meeting, university lectures, university circle meetings. It is very important to maintain proper security, which is a common problem of IoT in general. Commercial product can not be released without preparing proper security policy layer and implementing it a part of concept three-layer system, which will of course change into a four-layer system.

Further direction of concept development may follow on a suggestion of one of the test users, who really enjoyed talking to TOMTE inside an application layer. Based on a user's personal data, a unique chat bot can be customized, a bot that knows a lot about the user, even more than a user itself in some cases.

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Appendices

A Design Process

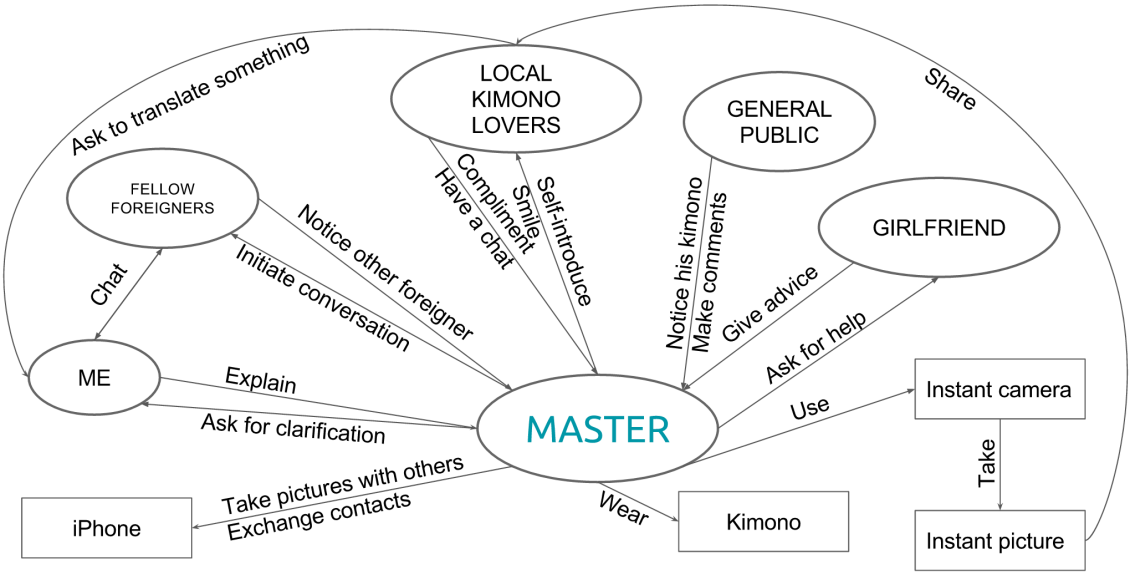

Figure A.1: Flow Model

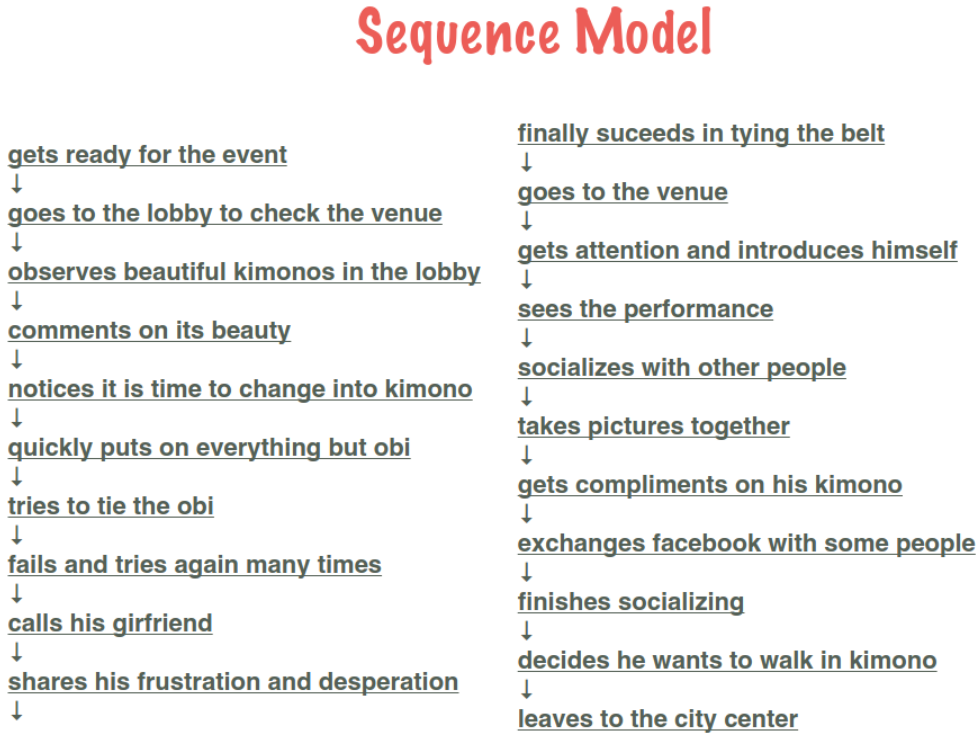

Figure A.2: Sequence Model

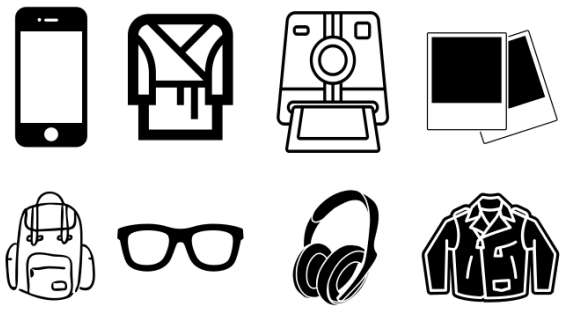

Figure A.3: Artifact Model

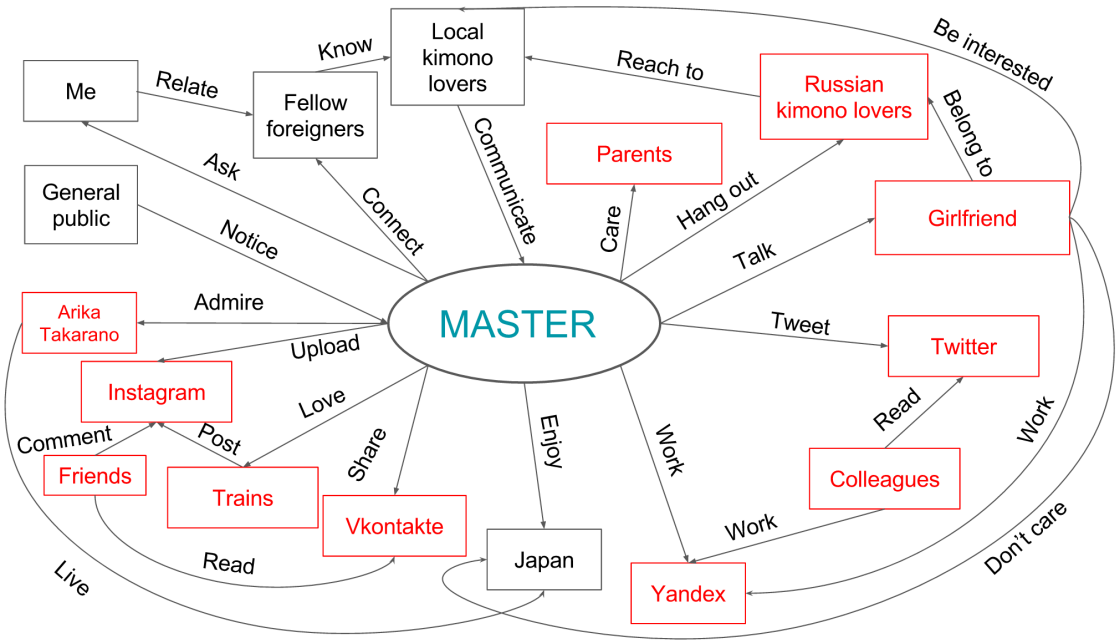

Figure A.4: Cultural Model

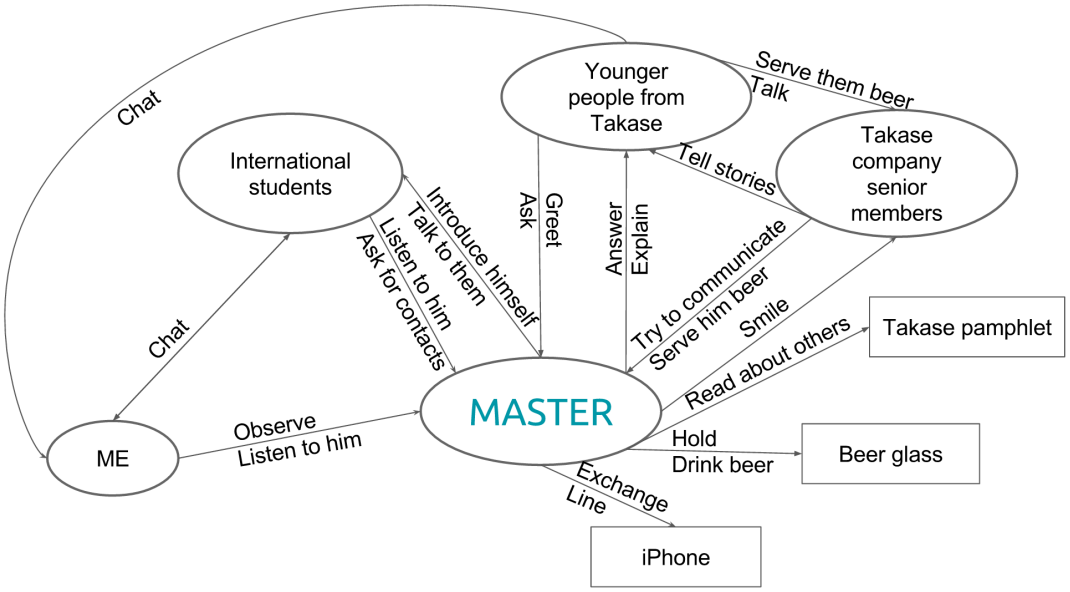

Figure A.5: Flow Model 2

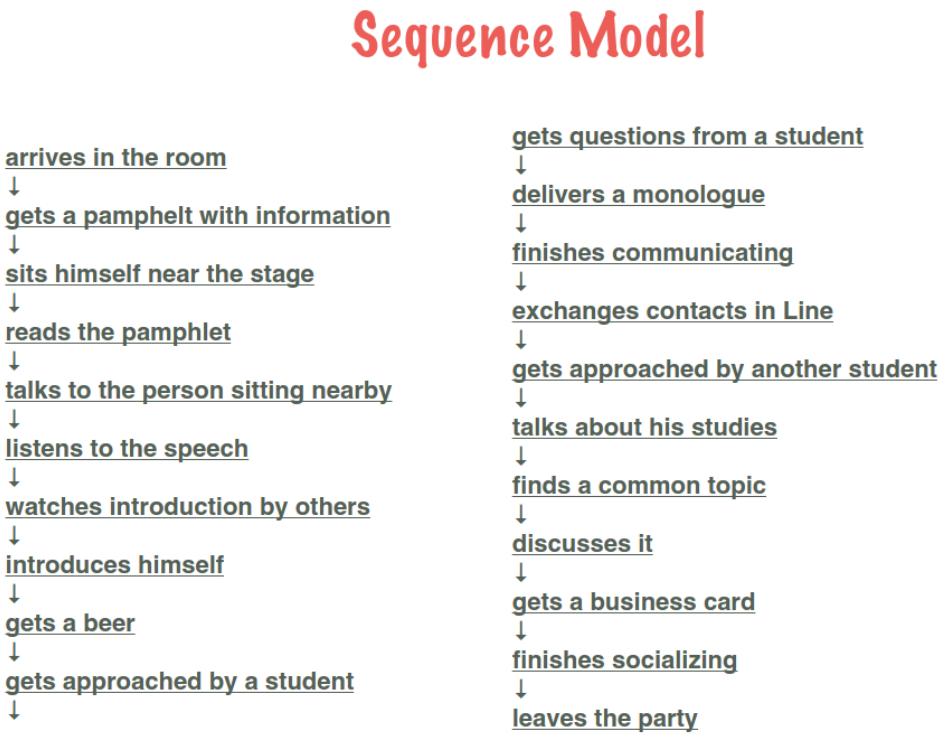

Figure A.6: Sequence Model 2

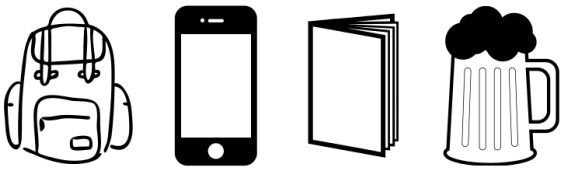

Figure A.7: Artifact Model 2

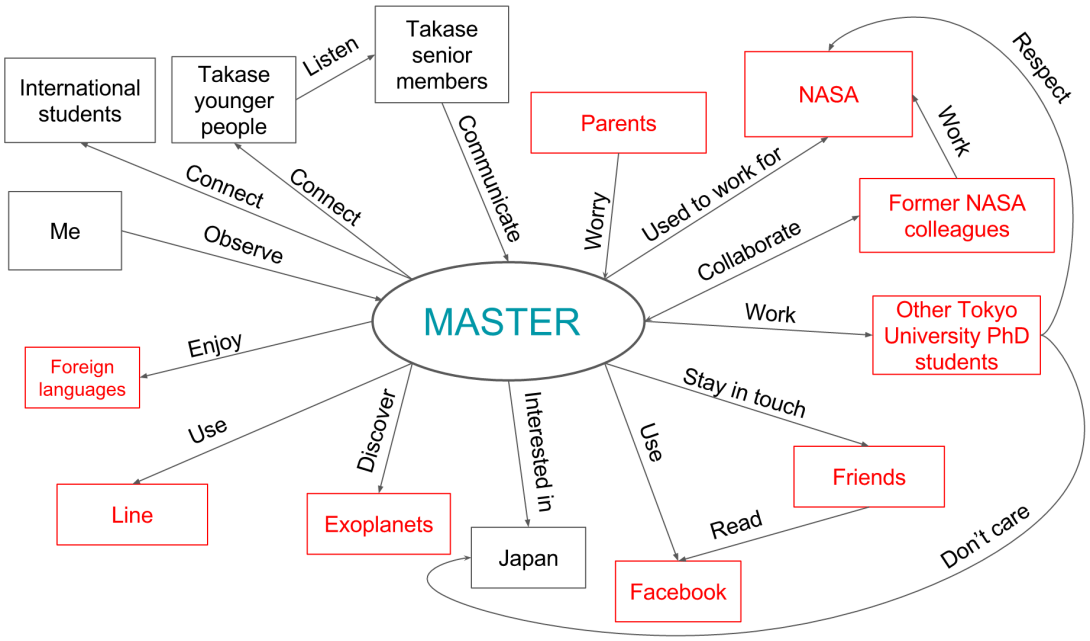

Figure A.8: Cultural Model

B Surveys

Pre-test

- Age
- Gender
- Country of origin
- Occupation
- Do you think your social circle (friends, acquaintances) got smaller after moving to Japan?
- How often do you go to events with a prior goal to meet new people or to make new friends?
- Do you find it hard to approach new people at such events?
- Do you have a certain way to approach people (a line, a phrase etc.) or do you usually improvise?
- Do you usually exchange contacts after you made a new connection? Do you ask for Facebook, Twitter, Line etc.
- How often do you add suggested friends on other social networks?
- If you have met a person at a party or other social event and see them in your suggested friends list on Facebook, Line or other commonly used social network, will you add them?

Interaction test

- What is your preferable communication distance? Could I measure it?
- Do you feel differently when holding TOMTE?
- Do you feel that I am not intruding your personal space when talking to your TOMTE?
- What do you think about the LED interaction? Could you figure out what activates it?

- Does TOMTE remind you of something?
- Do you see a face or just a sensor?

Scenario test

- How will you feel if you receive encouragement message from your TOMTE after a failed conversation?
- When a party is over, your TOMTE mentions it liked the same person as you did. Your reaction?
- Could you share the fact that TOMTE like them to other person?
- Any other feedback?

C Prototype Arduino sketch

```
/*
/Tomte code. Uses code from example sketches
for Wire, NewPing, RTC libraries
/and NeoPixel interactions by Phoenix Spalding
*/

#include <Wire.h>
#include "DS1307.h"
#include <NewPing.h>
#include <Adafruit_NeoPixel.h>
DS1307 clock;
#define TRIGGER_PIN 7
#define ECHO_PIN 8
#define MAX_DISTANCE 400
#include <SD.h>
#ifdef __AVR__
  #include <avr/power.h>
#endif
#define NEO 6
File myFile;
NewPing sonar(TRIGGER_PIN, ECHO_PIN, MAX_DISTANCE); // NewPing setup
//of pins and maximum distance.
Adafruit_NeoPixel strip = Adafruit_NeoPixel(1, NEO, NEO_RGB + NEO_KHZ800);
const int  buttonPin = 2;    // the pin that the pushbutton is attached to
int buttonPushCounter = 0;   // counter for the number of button presses
int buttonState = 0;         // current state of the button
int lastButtonState = 0;     // previous state of the button
int i = 0;

void setup() {
  Serial.begin (9600);
  clock.begin(); //start RTC clock
  pinMode(10, OUTPUT);
  SD.begin(4); //initialize SD card
  strip.begin(); //initialize LED
  strip.show();
}
```

```
void loop() {
  delay(200);
   buttonState = digitalRead(buttonPin);

  // compare the buttonState to its previous state
  if (buttonState != lastButtonState) {
    // if the state has changed, increment the counter
    if (buttonState == HIGH) {
      // if the current state is HIGH then the button
      // wend from off to on:
      buttonPushCounter++;
      myFile = SD.open("logs.txt", FILE_WRITE);
      myFile.println("Interaction start");
  myFile.close();
      Serial.print("number of button pushes:  ");
      Serial.println(buttonPushCounter);
    }
    }
  // save the current state as the last state,
  //for next time through the loop
  lastButtonState = buttonState;
  if (buttonPushCounter % 4 == 0) {
            strip.setPixelColor(0, strip.Color(5, 0, 0));
        strip.show();
         myFile = SD.open("logs.txt", FILE_WRITE); //writes interaction data
      myFile.println("Interaction finish");
       //shows interaction finish when there is no interaction in logs
      myFile.close();
  }
  unsigned int uS = sonar.ping_cm();
  clock.getTime();
  myFile = SD.open("logs.txt", FILE_WRITE);
  Serial.print(clock.month, DEC);
  Serial.print("/");
  Serial.print(clock.dayOfMonth, DEC);
  Serial.print("/");
  Serial.print(clock.year+2000, DEC);
  Serial.print(";");
```

```
 Serial.print(clock.hour, DEC);
 Serial.print(":");
 Serial.print(clock.minute, DEC);
 Serial.print(":");
 Serial.print(clock.second, DEC);
 Serial.print(";");
 Serial.print(uS);
 Serial.println(" ");
 myFile.print(clock.month, DEC);
 myFile.print("/");
 myFile.print(clock.dayOfMonth, DEC);
 myFile.print("/");
 myFile.print(clock.year+2000, DEC);
 myFile.print(";");
 myFile.print(clock.hour, DEC);
 myFile.print(":");
 myFile.print(clock.minute, DEC);
 myFile.print(":");
 myFile.print(clock.second, DEC);
 myFile.print(";");
 myFile.print(uS);
 myFile.println(" ");
 myFile.close();


if (clock.second == 29)
{
  for (int i = 15; i < 30; i++)
  // 'i = 0' represents the minimum brightness,
  // 'i < 255' is maximum brightness.
  // Adjust number values as desired.
   {
       strip.setPixelColor(0, strip.Color(0, i, i));
       strip.show();
       delay(1);
   }
   for (int i = 15; i < 30; i++)

   {
```

```
        strip.setPixelColor(0, strip.Color(0, i, i));
        strip.show();
        delay(1);
    }

    for (int i = 15; i < 200; i++)

    {
        strip.setPixelColor(0, strip.Color(0, 0, 0));
        strip.show();
    }

       }

   if (1 < uS && uS < 49 ) { //interaction
   // that happens when distance is less than 49 cm

        strip.setPixelColor(0, strip.Color(30, 0, 30));
        strip.show();
        }
    // This is where the LED On/Off happens
 if (51 < uS && uS < 400 )

{
   strip.setPixelColor(0, strip.Color(0, 0, 0));
        strip.show();
        }
}
```