Connected Everyday Things

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Executive Summary

In this document, the results of the project ‘Connected Everyday Things’ are reported. Over the past decade, the way we interact with the Internet has fundamentally changed. Whereas in the earlies days a bulky computer in the living room or office was the only means to connect to this digital world, today Internet access is achieved through a variety of devices such as notebooks, tablets and smartphones. Over the past few years a new trend which some call the second digital revolution has emerged. This trend describes the phenomenon of a multitude of physical objects connecting to the internet and is therefore named the internet of things, or IoT. According to prognosis, 50 to 100 billion devices will be connected to the Internet by 2020. The internet of things is hot. Left and right new products pop up that are labelled ‘smart’ because they are connected to the internet. However, designers and researchers struggle to reach consensus on how a future connected world should look like. How can smart connected products be part of our future daily lives?

The authors went through an iterative design and research process in order to attempt to answer this question. While performing multiple iterations of research, ideation, prototyping and consulting experts, the authors developed a vision on a future of connected products that are part of everyday life. This vision was translated into an approach towards designing connected products, and is proposed as a guideline for the authors themselves as well as for other designers. First of all, one should understand that everyday life is complex. Therefore connected products ideally should not introduce new complexity to this everyday life but rather build on the complexity that already exists, thus making it easier for them to become part of everyday life. Furthermore people should be identified and respected as practitioners. By discovering and understanding their practices in everyday life, implicit relations between products and humans can be identified. These implicit relations pre-eminently offer opportunities to design connectivity that add to the experience of everyday life. This is in contrast with the trend of automation, which actually dissolves practices of people.

A second result in the form of three concept proposals is also presented to display a practical outcome of the proposed approach towards connected products. The three concepts all portray how existing implicit relations between products can be made explicit by means of a digital connection and product behaviour, in the practice of receiving mail, securing a house, and watering plants. These concepts were created in the form of functioning prototypes to experience and debate their functionality and relevance, the results of which are discussed.

Finally, the complete design and research process is described in two iterations. The report is concluded with a discussion and personal reflections of the authors.

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Introduction

About the design team

Jip Haarsma, BSc.
Jip Haarsma was born in the Netherlands in 1994. He is an Industrial Designer with a special interest high quality materialisation and perceived aesthetics of concepts. He received the BSc. degree in Industrial Design from the Eindhoven University of technology. He is currently a Graduate School student at the Faculty of Industrial Design at TU/e. Alongside his studies he works as a Product Designer, Graphic Designer and student assistant at TU/e.

During his studies he has been focusing on various product design projects in the field of Interaction Design and Human-Centred Design. With his designs he tries to restore value in consumer products using mass production, craftsmanship and in depth knowledge of materials, production techniques and trends in art and design.

Luke Noothout, BSc.
Luke Noothout was born in the Netherlands in 1994. He is an Industrial Designer with a special interest in creating sustainable human-product relationships. Currently he is a Graduate School student at the Industrial Design faculty of Eindhoven University of Technology. Besides studying he also works as an Interaction Designer, a Graphic Designer and a Student Mentor at TU/e.

He is interested in the relationship between people and the products they use, especially in the context of technological devices. Through interaction design he attempts to evoke meaningful bonds between product and user, and find new ways to build these relationships. By combining conceptual thinking and high quality prototyping he attempts create products that evoke this vision in users.

Bart Versteeg, BSc.
Bart Versteeg was born in the Netherlands in 1993. He is an Industrial Designer with a special interest in business design. With a technological background of Technasium high school education he entered his Bachelor study of Industrial Design, from which he graduated Cum Laude. He currently is a Graduate School student at the Industrial Design faculty of Eindhoven University of Technology.

Besides studying for his Master's degree, he works as an Innovation Consultant for an agency that specializes in strategy- and service design. He is Lead Strategic Developer for a web agency and also works for the Department of Industrial Design of the TU/e. His main interest and expertise is to design sharp value propositions that result in product/market fit.

About the project ‘Connected Everyday Things’

In our everyday life a lot of things are connected. Think of a mobile phone that explicitly connects to a speaker via an audio cable, but also think of a water bottle that shares an implicit relationship with a water tap. The project ‘Connected Everyday Things’ aims to explore these relations of everyday things to people, environments and other objects in an era of connectedness. Designers involved in this project try to investigate what connected things can be; how they can create meaningful futures by connecting to the old products and current practices of people.

Next to the topic of connected everyday things the project focuses on the following related themes:

1. Analysis and inquiry on everyday practices in the home, work, and elsewhere on the nature of, impact, and potential of creating sustainable and meaningful relations among and with connected things.
2. Crafting and prototyping future connected things that highlight, address and support the matters of concern of everyday practices and life.
3. Material speculations and design fictions that investigate the potential and implications of connected everyday things well into the future.
4. Emergent themes related to everyday connected things that focus on aesthetic, critical, ethical and sustainable approaches to the Internet of Things (IoT).

Because the aim of the project is to get an understanding of the relations between proposed products and their intended users it requires a specific approach towards the design process. In order to evaluate products in their context they should be placed in this context for a considerable period of time that ensures the elimination of temporary excitement caused by the novelty of the product. For this reason the designs introduced by this project have been created to resemble finished and operate like functional products relatively early in the process.

About this report

This report describes the vision of the designers involved in the project ‘Connected Everyday Things’ on the current developments in the field of connected devices and IoT. Furthermore the designers propose a possible approach towards designing meaningful connected everyday products. The application of this approach is explained through elaborated concepts of connected products. The final section of this report describes the process the designers went through including the substantiating research, involvement of experts in the field and deployment of prototypes.

II

Relevance of Connected Everyday Things

The internet of things (or IoT), is a name given to a trend of connecting physical objects to the internet. The prognosis is that by 2020, 50 to 100 billion devices are connected to the Internet [1,2]. It is a result of the combination of the Internet in its entirety and emerging technologies such as NFC, RFID, GPS, LoRa, sensor platforms and others [3,4,5]. Sensor networks, embedded technology and machine-to-machine communication are not new as many industries have already embraced them in specific applications, but an internet of things where communication is standardized, platforms are interoperable and a 'thing' is properly defined is far from achieved [1,3,4,6,7,8,9,10].

Nevertheless, the development of the IoT has drawn the attention from many parties in the private sector as well as from academics, governments and cities [2]. There is no consensus yet on how to realize a 'good' internet of things [3,6]. Progress in technology however continues unabated; sensors are becoming smarter, cheaper and perhaps most important, smaller [8]. This development allows for deeper integration of smart technology into objects [3,6,9,11]. In the project 'Connected Everyday Things', a special interest is taken in the integration of this smart technology into everyday objects. In the introduction of 'The internet of things: the next technological revolution' Feki et al. describes the paradigm shift in which everyday objects become smart and interconnected, which is also noted by Kortuem et al., Guinard et al. and Mainetti et al. [3,4,10,12].

The Internet itself was built as an infrastructure network to reach out to end-user terminals. This conventional concept will fade, clearing the way for everyday physical smart objects to integrate into the emerging global cyber-physical world [9]. However, this shift forces us to rethink how these physical objects communicate with each other and/or with humans [3,6,9]. Whereas most research efforts until now have been put into developing technology standards and protocol stacks a second, arguably bigger challenge, is to seamlessly integrate these objects into everyday life [12,13]. As early as in 1991 Mark Weiser developed a vision on future ubiquitous computing linking integration of technology to the availability of processing power, stating that "the most profound technologies are those that disappear. .. they weave themselves into the fabric of everyday life until they are indistinguishable from it" [14]. Herein the industrial and interaction designer can play a prominent role in developing connected products.

When talking about connected products, one should not only think of networked versions of commonplace devices such as washing machines, coffee machines, fitness trackers or toothbrushes that are now available and labelled as 'IoT products' [2,4], but also pay special attention to embedded devices (or 'nodes') that can function as interfaces for a more complex (hidden) digital/virtual world while at the same time function as suitable actuators for bringing the digital/virtual into the physical realm [1,11]. The challenge lies in designing these interfaces for everyday life, since everyday life has a different meaning for each individual. An expected caveat is described in Borgmann's 'Device Paradigm' where technological artefacts are understood as mere providers, resulting in an everyday reality dominated by designed 'commodities', rather than a reality of meaningful experiences that are stimulated by means of using smart objects [3,15,16].

This is uncharted ground for designers. Like Fors and Stolterman state in their article "Everyday Aesthetics and Design of Information Technology", designers lack methods and approaches that bring forward a deeper understanding of people's everyday experience of technology, while at the same time they are expected to understand in what way people experience their realities formed by technological artefacts in order to create new products that fit in that same reality [15]. Connected Everyday Things will be important in the nearby future and may be a part of the second digital revolution, yet there is still a long way to discover how exactly they will manifest in the future development of the internet of things.

III

Approach

As technology progresses, more and more products turn into network enabled devices. This connectivity allows products to exchange data between each other and the internet. The resulting network of connected devices is often referred to as the Internet of Things (IoT). As the IoT grows and becomes increasingly commonplace, designers and engineers face the challenge of finding ways to integrate connected products into everyday life.

Although connectivity can very well be an added value for a product, adding it as a feature does not always make sense. There is an abundance of products being released that treat connectivity as a gimmick, a way to hook into the IoT trend. Examples of this kind of products are for instance the Juicero, the Hidrate and the Kuvée.

Juicero
Juicero is a countertop cold-press juicer [17]. It uses an internet connection to retrieve information about the package inserted, such as what farm the vegetables came from, what the optimal press settings are and whether the package is past its expiration date. If there is no internet connection available it is not able to perform these actions and thus will not function at all.

Hidrate
The Hidrate is a smart water bottle that pairs with smartphones [18]. It keeps track of how much water you consume from the bottle. An app allows you to set your goals and monitor your progress. It will also send you push notifications to remember you to stay hydrated.

Kuvée
The Kuvée is a smart wine bottle that allows users to look up information about the wine they're drinking and purchase new bottles of wine through a screen embedded in the bottle [19]. The value proposition is that the system significantly extends the expiration date of the wine, although the device itself is not necessary to use the wine containers.

All three of these examples are products that have been successfully funded and available for purchase, signifying that connected products are as popular as ever. But these three examples also illustrate a way of thinking where connectivity is merely a feature. Through connectivity the Juicero is able to provide more elaborate information about the juice that is being prepared, but it does not do this in a way that could not be achieved without a Wi-Fi connected juicer. Furthermore, at some points its connectivity even prevents the machine from fulfilling its main purpose: making juice.

The goal of this project is to explore new ways to approach the design of connected devices, where connectivity is not merely a feature but an integral part of the product and where connected products are designed in harmony with everyday life.

Everyday life and practices

When designing connected everyday things it is important to have an understanding of everyday life. Everyday life is invisible, in the sense that it is everything that does not stand out. It consists out of all the actions and interactions people go through every day without thinking about. It involves an abundance of people, spaces and objects that are not out of the ordinary. Everyday life is experienced and processed without thought: people don't think about it while going through it. As soon as something becomes out of the ordinary, it ceases to be part of the everyday.

Renowned Japanese designer Naoto Fukasawa describes everyday life through his credo "Without Thought":

> *"We designers have been working to stimulate people's souls and minds. But in reality I'm not thinking about [the] pen when I'm writing with it. Rather, it's when you least think about it that the pen can be held most naturally."*
>
> *[20]*

It is this understanding of the invisibility of everyday life that opens up new design spaces that can be explored when designing connected everyday things.

Although everyday life is invisible it is a very rich context to explore. As mentioned, every day people interact with an abundance of people, spaces and objects. All of these interactions make everyday life rich in complexity. A lot of implicit connections can be discovered between many of the things that make up everyday life. These connections provide an interesting starting point when designing connected devices.

A method for uncovering implicit connections in everyday life is Practice Theory [21]. Everyday life consists out of practices. A practice is behavior explained through material, competence and meaning components. The material component consists of all the artefacts, spaces and people involved. The competence component is the collection of skills and knowledge required. Lastly, meaning describes the reasons and motivations that drive the practice. By taking a practice and examining its components the complexity of an everyday context can be mapped out. Take for example the practice of cooking. Cooking requires a very specific set of objects operated in a specific space. This is the material component. The competence component involves learning how to cook and prepare food properly. The meaning component, which describes why people want to cook, differs per person.

Embracing everyday complexity

An interesting observation can be made about many connected devices on the market right now: they require smartphone applications (apps). These apps are needed for users to interact with the complexity presented by the devices. Often they convey abstract quantitative data or present the user with extended control over the device.

This is where an opportunity for designing connected devices presents itself. Rather than introducing new complexity, connected everyday things could originate from the complexity that is already present in everyday life. This can be done by exploring practices to identify implicit connections. These connections can then be made explicit through the use of technology. By doing so, connected products are created that are based on existing complexity.

However, this does not mean that all objects within a practice can simply be connected. Although they share implicit connections, the explicit connections have to make sense. When products become connected, they start to exchange data. It is up to the designer to identify what exchange of data is meaningful within the practice, and thus which products could be connected. Finding the right connection is not done at once, and requires a good understanding of the context and deployment of prototypes to validate assumptions.

However, when the sweet spot is found, the result is a connected product that makes sense in the context of everyday life. As these products share and react to meaningful information they become physical interfaces. Although the connection is often simple, there is a rich amount of data that can be communicated through the products. But because the system is built on everyday complexity the interfaces require less effort to be understood.

Practices and automation

How products are connected is not the only factor in designing connected everyday things. There is also the aspect of automation. As mentioned, everyday life is composed of practices. People can therefore be described as practitioners. They continually develop practices and make them their own. Respecting this authority of the practitioner is important when designing for everyday life.

Borgmann's device paradigm [16] describes the phenomenon that devices tend to diminish people from practitioners to operators. Because devices tend to simplify complexity rather than make it understandable, the role of the user is merely to operate the device. Interfaces are reduced to buttons and screens, reducing the the amount of materials and the level of competence involved in the interaction. This leaves little to no room for users to develop a practice.

One step further is automation. Many connected products allow users to automate certain actions. However, when talking about everyday practices automation is tricky subject. If a practice is automated, it becomes difficult to argue that it is still part of the everyday life of the user. When a device automates a practice, it takes the practice away and thus the user stops becoming a practitioner. In this sense, connected everyday things should respect users as practitioners: the everyday connected things should either fit into existing practices or users should be able to develop new practices around them.

The approach

Taking all of the above into account, an approach or guidelines can be defined for designing MEaningful COnnected Products for Everyday Life (MECOPEL).

1. Embrace everyday complexity
Connected everyday things do not introduce new complexity, but build on the complexity that already exists in everyday life. Because of this, they make sense in the context of everyday life.

2. Understand Practices
By investigating a practice implicit connections can be found that can form a foundation for connected products. Understanding the richness of a practice opens up the design space to explore different connections.

3. Make Meaningful Connections
When connecting products the connection should make sense. By understanding the practice it can be evaluated what kind of data exchange makes sense within the context. When a proper balance is found interfaces can be created that communicate the complexity in an intuitive and meaningful way.

4. Respect the Practitioner
Practices are part of the fabric of everyday life. In order for connected products to become part of everyday life they need to allow people to remain practitioners, and stay in control of their practices.

Translation to protocol

One of the most highlighted challenges the internet of things faces, is the widespread development of smart products and systems that are not based on (globally) agreed standards and rules. Because there is no consensus yet on how to design the exact infrastructure that could host the IoT, each manufacturer designs their products according to their own standards and protocols, resulting in a variety of interoperability issues [22]. An example to illustrate this. Three companies, Scout, iSmart and Wink all offer a full-package solution for a smart domestic security system [23,24,25]. All three have designed their own products, have chosen their own technology for wireless communication, have developed their own gateway, and so on. Suppose a user owns one of these security systems but wants to expand it by buying more modules, they are bound to buy from the same manufacturer, as the separate products are not interoperable.

This is not the internet of things it could be. Another example shows a different approach: Sense Mother avoids the problem of interoperability with a system that allows you to transform basically every (household) object into a node. You can stick their 'motion-cookies' to a chosen object so the cookie will monitor movement and temperature. With custom

apps, you define the meaning of the data [26]. This is a unique approach to connected everyday things, but instead of designing products that have smart technology embedded, they design a multipurpose sensor that you can indiscriminately stick to random objects. Other examples are that of companies who cooperate and connect each other's products by sharing API's [22].

However in all of these examples, connectivity is designed for a specific or limited application. The authors believe that in order to achieve a level of interoperability between connected products that transcends brands, intended use, and application domain, designers should look differently at the underlying network infrastructure. Without going into technical details regarding information technology such as networking protocols, protocol stacks, and hardware, the authors suggest a tool to visualize and grasp the possibilities of connectivity in the context of the domestic environment.

The tool proposes to index all connected products in a household using a state and category-based system. For convenience it is assumed that in a future scenario, these products automatically register to the network and therefore are immediately available. In the same future, all objects are uniquely addressable because ongoing development of the Internet Protocol (IP) allows for each device to have a unique IPv6 address [1,4,7]. However, people do not interact with the internet through complicated addresses. For this, the domain name system (DNS) was invented, for example to translate www.example.com to its correct numerical address.

Just like Karakostas proposes an experimental DNS for a transport logistics system [27], the authors suggest an experimental DNS especially made for creating a namespace for connected products in the home. Imagine *home* as the starting point or gateway for this namespace. Now imagine the status of the security of this home as a second level: *security.home*, an address to which all security-related connected products report to. Now, *security.home* can tell us how secure the home is. Still, we can broaden this. In the specific context of security, you have for example door sensors, motion sensors or window sensors. In the setup of this 'home DNS', door sensors will report to *doors.security.home*. An individual object (or 'node'), such as the front door, can be reached through *frontdoor.doors.security.home.* The structure of this namespace can be applied to many categories and themes, i.e. t*oyota.cars.transport.home*, l*ivingroom.tvs.entertainment.home* or *stove.appliances.cooking.home*.

The authors argue that by using this philosophy to think about connected products in the home, it becomes easier to discover relations between existing everyday objects that transcend the product category they are part of. Furthermore, this reasoning helps preventing the interoperability issues described above. Instead of traditional machine-to-machine communication, using the 'home DNS' as intermediate creates a scenario where products can 'listen' to changes in a state or category address (such as *security.home*) and at the same time report information back to this address. This removes the complexities of product-product communication.x

IV

Concepts

Letterbox

Context
When you look at a typical household, you can identify multiple streams of input such as water, electricity and gas, but also mail, internet and telephone. These streams provide excellent opportunity for designing connected products in the home environment, since they are so commonplace. From a context analysis that was done (as described in the context analysis in Chapter 5) and a simple ask-around it was learned that a lot of people have a location somewhere in their home where incoming mail is placed, be it already processed or unsorted. This may be in the form of a simple platter where mail is dumped , an inbox or just a corner of the room where mail is stacked up.

This location is already implicitly connected to another product that can be found within every home: the letterbox. In many homes, the letterbox is integrated into the front door. However all apartments that can be found in flats or residences that are located in a rural area have their letterbox separated from the home and located as close to the street as possible, due to Dutch regulations [28]. The letterbox and the “mail pile” in the home are related in a simple way: First, the mail enters the letterbox. Second, the mail is collected from the box and added to the mail pile, awaiting processing.

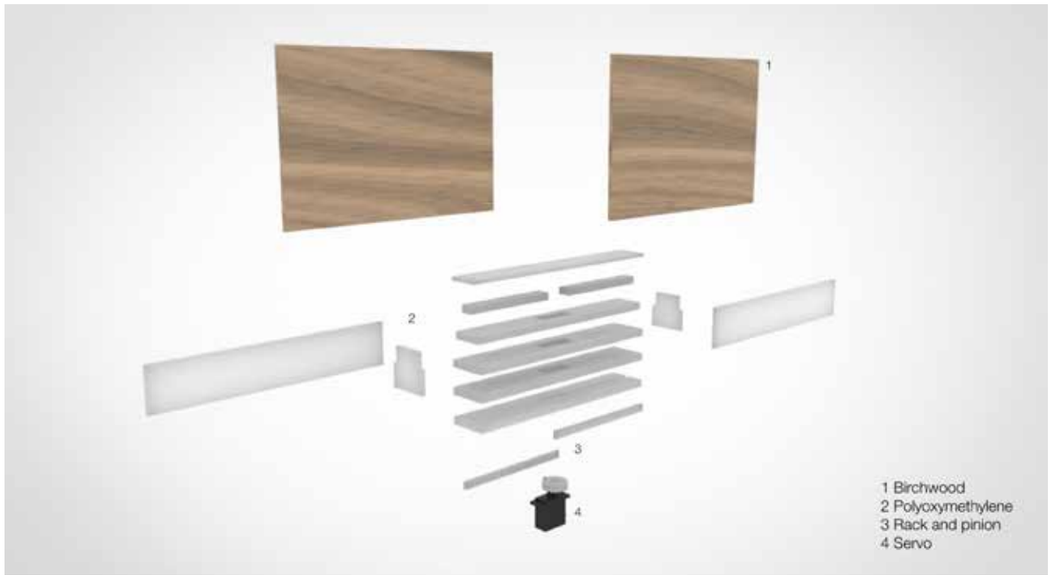
Following the proposed approach of designing connected products for everyday life (see Chapter 3), the goal in this context is to make this implicit relationship explicit by making a digital connection between the products. A letterbox is a fairly simple product. It has a narrow slot and a locked cover for the owner to collect mail. When looking at the letterbox as a ‘node’ in a network, it can tell when it got mail and whether the owner has collected it yet. In a hypothetical scenario where the letterbox is connected to the mail pile, the latter can use this data. This has also been achieved in the example product.

Design & Functionality
In this example , an elegant table-top letter holder was designed. The holder base is made of a polyoxymethylene (POM), a synthetic polymer. This material reduces friction on the rack and pinion and gives the holder enough weight to feel sturdy and decent. Two unprocessed birchwood boards are attached to the base to form the clip that holds the letters and to give it a more luxurious look. The letter holder can basically be placed everywhere. In this prototype a power cord is attached to provide power to the device, but a battery-based product is proposed for future versions.

As stated, this letter holder is connected to the letterbox. When a letter is inserted into the slot of the letterbox, the letter holder reacts by sliding the two birchwood boards apart in parallel. Each time more mail is presented to the letterbox, the boards will extend farther. This action is specifically designed for this context. The offset of the boards compared to the base is directly visually noticeable, and supposedly stands out when glancing the product. At the same time, by extending the birchwood boards farther apart of the (unprocessed) mail in the letter holder will present itself to the user, suggesting the unprocessed mail needs to be processed.
When the user collects mail from the letterbox, the letter holder retracts the boards and returns them to their initial position, waiting for the next time mail is delivered.

Discussion
Just like with the watering jar, the letter holder is an example of how connected products could earn their place in a common household. Using the MECOPEL approach, digital connectivity is added to an existing, albeit implicit relationship between two products that are already located in the home. The connectedness is expressed through the behaviour of the letter holder and is designed to be less obtrusive than other examples of connected products who try to get the user's attention by means of an app, notification or other visual or auditive signal. The designed behaviour is not constantly demanding attention, rather the appearance of the product itself is conveying information about the state of another product, namely the letterbox. The user can choose to ignore or act upon this information.

Although the prototype has not yet been deployed, it is assumed that a product such as the letter holder can be a part of everyday life because it remains a functional product in its inert state and does not require user intervention when expressing its functionality. One could argue that the letterbox simply sends you a notification on your smartphone when it has received mail, but this is not the way connected products are envisioned in the MECOPEL approach. You can hardly ignore a notification on your phone, while the letter holder can be in your environment without demanding your attention, until you glance at it.



Security Night Light

Context
Home is where the heart is. It is a place for leisure, love and fun, where you can be safe. A recurring theme in the Internet of Things is that of domestic security. Security systems with door and window magnets, motion detectors and alarms have already been present for some time. Following the trend of IoT, these home security systems are increasingly being connected to the internet. This enables the user to have total home control from a distance, keeping a waking eye through the cameras and getting notifications when a burglary has been detected.

A large part of a secure home is of course the responsibility of the ower. He has to lock the doors when he leaves, leave no windows open and keep valuables out of sight. The home should be secure when the owners are away, but perhaps even more important: the home should be safe when the owners are asleep. Securing a home for the night is the operating ground for this concept.

Everyone has a personal practice of going to bed, but it may for example include trivial things such as brushing your teeth, reading a book or having a last cup of tea. Whatever their rituals are, at some point inhabitants have to secure their home by locking the front and backdoor and close any open windows. But what is really the last part of the practice of going to bed? Without a doubt we can say that it is turning off the lights, before going to sleep. You are actively preparing yourself to go to bed. Then when you flip the switch, suddenly there is darkness. Only then will you start your sleeping period.

In this concept, the relationship between light fixtures and security is explored. It is assumed that everybody wants to go to sleep with a safe and worry free feeling. Turning off a light can function as an interesting point of intervention to relay information about the state of the security of a home.

Design & Functionality
To design this intervention a medium is needed. It is assumed that the last light you switch off is the lamp on your nightstand, but it could also be another fixture. The traditional night light has a simple pull-switch to turn it on and off. In this concept, the night light reacts to the state of security of a home. If everything is fine (all doors and windows closed and locked) nothing out of the ordinary happens, the user can just pull the switch and the night light turns off.

However, if the security state is 'unsafe', something different happens. When the user tries to turn off the night light by pulling the switch, the night light does not turn off. So although the user pulls and hears clicking noise, the night light still shines bright. This alerts the user that something is wrong in the home and gives him the opportunity to examine what is wrong. However, a second pull will still turn off the light. This way, the user can ignore the signal and simply go to sleep.

Discussion
This concept follows the MECOPEL approach to a certain extent. It explores an implicit relationship between products in a practice and tries to make this relationship explicit by means of a digital connection. In many discussions, including one with NXP semiconductors, people agreed that communicating the state of security through this specific interaction with a night light is a very subtle way to present information without use of screens. In a demo that was setup at the Eindhoven University of Technology where people could experience the concept, the interaction was described as 'powerful'.

However, utilising this implicit relationship between a night light and security was based on the assumption that people in general are occupied with home security when they are preparing themselves for sleep, e.g. 'Did I lock my front door?'. This is of course not the case for everyone. The concept might have made more sense if it was presented as a generic table lamp. Then, when turning off the lights in the living room before going to bed, the notion of a safety problem could be dealt with while still having to perform tasks. Furthermore, the concept is meant to simplify interaction with a system, but it unfortunately also adds complexity, e.g. the user does not know whether all sensors or the lamp are functioning correctly and could even become suspicious about whether or not he pulled the switch correctly. Therefore this concept does not fully represent the vision the team tries to communicate. Rather it can be seen as a process step.

Watering Pot

Context
Personal taste is a strong influential factor in home interior decoration. One family might like a stylish, minimal décor whereas others may prefer an antique collection of furniture. Taste is not debatable. However, in almost every living room, there are plants to add a bit of nature to the interior. Sometimes an arrangement of plants in the windowsill, sometimes one large plant and sometimes just a few small planters on the dinner table. Plants are alive and bring an aesthetically pleasant element into every environment.

Plants, unlike furniture, require special attention. Most plants need plenty of sunlight and water to survive. For this, most people have a small watering pot to water the plants regularly. Most of the water is soaked up by the plant but part of the water is evaporated by the sun. Logically if a plant dries out, it dies. Therefore, the practice of watering plants needs to be sustained for as long as the owner wants the plant to live. Imagine a plant that could communicate to its owner exactly how much water it needs and when.

In the practice of watering plants, there is already an implicit relation between the watering pot and the plants. The watering pot is often bought for the sole purpose of watering the plants. Thus in essence, they are paired. With the MECOPEL approach in this concept it is explored how the implicit relation between plants and a watering pot can be made explicit through digitally connecting the two.

Design & Functionality
The design consists of a wooden board made from American Oak that supports two glass jars. The larger jar functions as a water reservoir and contains a pump connected to a polished copper delivery system. The smaller jar can be used as a watering pot. This installation can be connected to multiple planters that are equipped with moisture sensors. These sensors communicate their moisture level back to the installation. Upon receiving of this information, the installation fills

the watering can with an appropriate amount of water. This is a gradual process, so every time a planter slightly desiccates , more water is added to the watering pot. The system understands how many planters are connected and therefore calculates exactly how much water per planter per increment of desiccation needs to be added to the watering pot, making sure it will never overflow.

When the user picks up the watering pot and waters the plants, the planter will communicate back to the installation that the soil it contains is saturated, so the installation can monitor that planter again to repeat the process all over.

Discussion

The watering jar concept introduces connected products to the living room in a way that is easy approachable. The installation is designed to be beautiful; something that deserves a place in your home, unlike a watering pot which will likely be tucked away in a cabinet until needed. The installation requires no technical knowledge whatsoever, and communicates with the user in an elegant way. On the one hand, the user can hear the watering jar being filled up, which is a signal that invites interaction. On the other hand, the water level in the smaller jar immediately visualizes how much water the plants need and therefore how dry the planters are.

One could argue that with the same technology, an automated irrigation system could be build. Like the MECOPEL approach prescribes, the concept respects the user as a practitioner. Therefore the objective is not to replace the existing practice of watering the plants by introducing yet another home automation product. Rather, the proposed connected products add value to the current experience by making the user more aware of the 'living' living room and subtly provide indicators and tools to fulfil the practice.

v

Process

During the project an iterative process was followed that can be divided in two cycles. These cycles roughly followed the same steps of understanding, vision development, ideation, prototyping and validating. In this chapter the process will be described and the contribution of each step will be explained.

Cycle 1

Understanding
- Context Analysis
- Literature Research
- Expert Input

Vision development
- Framework
- Unaware Interactions
- Practices of Transition

Ideation
- Unaware objects
- Disobeying objects

Prototyping
- Technological Challenges (Node)
- Prototype 1: Night light

Validation
- Demo Day
- NXP
- prof. dr. Ron Wakkary
- Deployment

Cycle 2

Understanding
- Diary Study
- Expert Input (Stephan, coaches)

Vision development
- Everyday complexity

Ideation
- Connected Everyday Things

Prototyping
- Prototype 2: Watering Jar
- Prototype 3: Letter holder.

Validation
- Deployment

Cycle 1

Understanding

Context Analysis

The first phase of the project was aimed at understanding the context for which would be designed: everyday live. More specifically the context of the home was chosen, as it provided a rich source of everyday objects and interactions. In order to get a good and thorough understanding of this context a context analysis was performed. During this context analysis the team visited the parental houses of two of the team members, Bart and Luke.

During the context analysis the parents were asked questions about objects in their houses. These questions were mainly focused on identifying why the objects were kept, why they were kept in a specific space, and if they were related to other objects. Each object that was discussed was photographed. Afterwards, a picture of each object was printed along with background information. These prints were then used to identify common themes or relationships among the objects. By doing so an understanding was created of the complexity of the context of the living room, which helped defining the design space of the object. Furthermore, it provided insights in the relationships people have with the objects they keep around, which helped creating an understanding of how products could be designed for everyday life.

Literature Research

In order to understand the state of the art of connected products and the Internet of Things, literature research was done. The research was approached from three perspectives: a technological perspective, a business perspective and a philosophical perspective.

The research into the technological development of connected products led to the insights described in the chapter Relevance of Connected Everyday Things (see Chapter 2). Understanding this technological context proved to be crucial in defining a new approach for designing connected everyday things.

Research into the current business perspective of IoT was done to get familiar with the elaborations of the vision of IoT [29] by market leading companies. It revealed the extensive amount of businesses that are focusing on laying the ground for the future vision of a world in which every product is connected to the Internet. A distinction was made between companies that are creating the infrastructure for the IoT and companies developing products or applications with the purpose of realising this future vision.
For example Intel, Microsoft, NXP, Oracle, Axeda, Atmel, KPN, Cisco amongst others are already founding the IoT by developing protocols (see Protocol, Chapter 3) to support interoperability amongst emerging technologies [3,4,5]. This focus of influential companies on creating the essential basis for IoT could be described as a positive development. Nevertheless the research into current applications and products showed something different. Companies such as Google, Amazon and Oral-B that invest largely in the development of consumer products sell 'IoT' products like Google Nest, Amazon Kinesis and Oral-B PRO 7000. Although these products are all connected to the internet they each communicate through different technologies and protocols, resulting in the lack of interoperability which seems to conflict the vision of IoT that can be abstracted from the developments of the founding infrastructure.

Research into the philosophy behind connected products and the IoT resulted in interesting insights. It became apparent that the main driving force behind the development of connected products is technology push. Because products are capable of harnessing connectivity, a lot of products get equipped with connectivity. Although guidelines such as the Internet of Things Design Manifesto [30] have been proposed, they are not widely integrated and remain a statement more than anything else.
During the research a bold statement drew the attention: 'The Internet of Things is broken'. The quote belongs to Alasdair Allan, but was found in a presentation from dr. Dries de Roeck for the 2014 Internet of Things Philosophy conference. [31] By examining De Roeck's work it became clear that developing a clear and coherent vision on connected products would become one of the main challenges of the project.

Expert Input

At this stage of the process expert input was used to identify interesting directions worth exploring. During weekly meetings the experts provided feedback on the progress shared their own knowledge and expertise.

Dries de Roeck was asked for feedback as an external expert. His work as a design researcher focuses on the integration of technology in the everyday life of people. After initial contact via email, a trip was made to Antwerp to visit his office at Studio Dott. Here the initial insights of the team were discussed and knowledge and insights were exchanged. His feedback and expertise was used extensively throughout the process.

Vision development

Framework

After the research it was decided that the starting point for designing connected products should be a vision rather than technology. And thus a vision needed to be created for everyday connected things. 'Meaningful' became a keyword in this process. It is a word that is often used but rarely defined. From internal discussions, the context analysis and discussions with experts and other students it was derived that meaning is not inherent to an object, but is something that people project onto objects. This mechanism is part of the 'narrative identity' [32] of people.

A key moment was the introduction of 'practices' by Ron Wakkary [21]. This theory provided the insight that 'meaning' is in inherent part of the practices that build up everyday life. The easier it is to include a product in a practice, the more meaningful it would become to the user.
Borgmann's Device Paradigm [16] is related to this. Borgmann argued that devices tend to reduce people from practitioners to operators. Following this, devices tend to take practices away, and therefore reduce the material, competence and meaning component involved in using the device. In order to maximize the likelihood that a connected product can become meaningful, the Device Paradigm needs to be avoided.

The need arose to cluster all the insights gained so far in such a way that they could be used in the design process, and thus a framework was devised. This framework was geared towards avoiding the Device Paradigm and described the stages that could lead to product becoming part of the narrative identity. These steps were:
Weak goals: Weak goals are application of a product that are not the main purpose of a product. For instance, a weak goal of a coaster is utilized when it is used to stabilize a table.
Multi stability: The more weak goals a product can fulfill, the higher it's multi stability.
Practice: The higher a product's multi stability, the easier it is to incorporate the product into practices.
Meaning: When a product is incorporated in a practice it gains a certain meaning for the user.
Narrative Identity: when a product develops a meaning component, it becomes part of the narrative identity of the user. The product is part of the story of the user's everyday life.

Unaware Interactions

Whereas the framework provided an understanding of what aspects are important to consider when designing for the context of everyday life, it was not yet formed into a vision that could guide a design process from ideation to prototype. There were still more pointers needed that would provide a clear starting point for ideation.

One of these pointers presented itself by exploring the work of a designer that seems to have a deep understanding of the small interactions that make up everyday life. Naoto Fukasawa is famous for his credo 'Without Thought' [20]. He argues that the majority of interactions during the day happen without thought, and as soon as something enters the consciousness it stops being an everyday thing.

This triggered the activity of exploring and documenting traces of unaware interactions, behavior that happens without thought. This exploration provided a better understanding of how these traces could spark ideas for new concepts.

Practices of Transition

The vision was further refined by one of Fukasawa's designs. 'Light with a Dish' is an example of a product that feels in harmony with everyday live. [33] It is designed within the transition from being at work to being home, dropping one's keys and wallet and flicking the switch both literally and as a metaphor for this transition.
It is an example of how an analogue product could be designed around implicit relations between objects. The light is designed for the practice of coming home, and connects several material aspects (the keys, the wallet, the light) of this practice.

The fact that this practice revolves around the transition from 'work-mode' to 'home-mode' is especially interesting in the context of connected products, because transitions can be very complex to automate. Here a design opportunity presented itself by exploring the design space between manual control and automation. It is in these practices of transition that the system could ask for input of the user. By using unaware interactions as a way for the system to communicate, connected products can be designed

that blend in into everyday life: the system is simply invisible when it does not need input.

Ideation

Initial Ideation

The first ideas were very lo-fi and more exploratory of nature. A vision was not yet leading during the development of the first ideas. However, some ideas provided some interesting insights. One of them was a coffee machine that would brew stronger coffee in the morning when the user's email inbox was fuller. This idea came from the practice of checking emails in the morning and is an exploration of how an implicit relation can be used to convey data to the user.

A second idea was that of coasters that could convey information to the system. It was developed from the notion that when someone has guests he will put more coasters on the table than usual. From this an automated home could adjust to this new situation by for instance turning on the coffee machine or changing the light setting. This idea illustrates how information can be deduced from everyday actions performed by users.

Disobeying Objects

As the team's vision developed further more concrete and funded ideas were developed. These ideas were triggered by the observation of a specific door that is normally always open. This door went unnoticed until one of the designers ran into it because it was closed. Doors are a good example of objects that we extensively interact with in everyday life without noticing them. The only times they enter our consciousness is when they behave in unexpected ways, for example a door that is expected to open when pushed while it actually should have been pulled.This observation sparked the idea that everyday things could present themselves into the user's consciousness by being 'disobedient', in order to communicate or ask for input.

The first concept that was developed following this insight was the disobeying door: a front door that refuses to close when the user leaves his keys inside. The idea revolves around the practice of leaving the house. Keys are essential to enter the house upon return and therefore should not be forgotten. The system alerts the user by breaking the unaware interactions. By being disobedient the system enters the user's consciousness, making the user aware of the practice he is executing, and alerting him that something is wrong.
It is then up to the user to either act upon this alert and investigate what is wrong or ignore the alert and close still the door.

The second concept was a night light that is connected to the doors in the house. It was based on the practice of going to bed. When going to bed people go through a ritual of securing the house, which includes closing windows, turning off devices, and, most importantly, locking doors. The night light will refuse to turn off the first time when a door is left unlocked. Again, the disobedience serves as a way to alert the user, who can then decide to interact or ignore. (see Night Light in Chapter 4)

Both concepts fall into the design space between manual control and automation. A common way for systems to communicate with users is by providing access to the complexity through screen based interfaces such as smartphones. The proposed interventions serve as an intermediate step before interacting with the complexity of the system, eliminating the need for push notifications.

Prototypes

Technological Challenges

Contemplating connected products from behind the desk only gets you so far. In the project 'Connected Everyday Things' it is stimulated to develop prototypes that are deployable, meaning they are robust enough to leave the design studio and can operate for a longer period of time without creator's intervention. Therefore a prototyping platform for connected products was needed, not only for the first concept, but also for the ones following after. To give the team more creative freedom, it was decided this platform should be as open-ended as possible to allow multiple types of use, with the following requirements:

- Low power consumption
- Wireless connectivity
- Small dimensions electronics
- Long range
- Mesh network type

After comparing many options in wireless connectivity such as ZigBee, Bluetooth, WiFi (ESP2866) and RF, the decision was made to use the upgraded version of the NRF24L01 chip that uses Radio Frequency to transmit and receive data. Although a popular choice in many wireless prototypes, WiFi was consciously rejected because it requires authentication to a network while RF works regardless of WiFi access point availability. With a custom designed circuit-board, the NRF24L01 was combined with a low-power Arduino Pro Mini and a smartphone battery charger of 2600 mAh. This hardware collection formed a node that could be used in many applications. Multiple nodes were made.

For communication between the nodes, a customized version of the MySensors library [34] was installed. With this customized library, the nodes all automatically search the frequency band for other nodes and form a mesh network. The hardware profile together with the software forms a very strong and reliable wireless network of nodes that could be used for prototyping. These choices allowed the team to focus fully on product and interaction design in prototyping sessions instead of spending many precious hours on getting the (often difficult to achieve) wireless communication working.

Prototype 1: Night Light

In order to be able to experience and validate the concept a prototype was made of the night light concept. The developed nodes were used to create the wireless connection needed for the communication.

The setup consists of a night light and two magnetic door sensors. The door sensors register whether or not a door is open by checking if a dedicated magnet is still next to the sensor; if not the door has been opened. The magnet is detected by a hall-effect sensor. The node processes the incoming data of the hall-sensor and sends it to the node in the night light, which interprets the reading as 'safe' or 'unsafe'.

The night light is retrofitted with a pull switch because it offers a richer interaction than the normal switch attached to the power cord. The node in the night light controls a relay that controls the power. When both the door nodes report a safe state to the night light the pull switch directly controls the relay, meaning that a single pull turns the light off. However, if one or both nodes report an unsafe state, the first pull on the pull switch is ignored. A second pull is then needed to turn of the light.

In the period around the midterm 'Demo Day' the first vision, concepts and prototype were presented to multiple audiences with the purpose of receiving feedback and validating the choices made during the process.

Validating

Demoday

During the midterm 'Demo Day' researchers and students were able to experience the prototype and give feedback. The idea of 'glitching' small interactions as a way for a system to communicate with a user through objects was deemed very interesting. The aim of avoiding the use of screens to convey complexity was appreciated.

NXP

A second opportunity for validation was an expert meeting with engineers from NXP. NXP develops hardware components; the department that was visited is responsible for creating concepts that communicate

what can be achieved with NXP products. Among these concepts was an array of connected, Internet of Things products.
The NXP engineers also deemed the direction of the project interesting, and appreciated the novelty of the idea. With NXP the technological challenges of the project and ways to tackle them were discussed. Since the engineers were specialized in the communication of concepts through prototypes their input was used for setting up the deployment and exploring how aspects such as end-user programming could be designed.

prof. dr. Ron Wakkry
The third, and arguably the most influential moment of validation was when the progress so far was discussed with prof. dr. Ron Wakkary. Although he appreciated the proposed approach for designing everyday connected things, he argued that there were a number of contradictions and missing pieces in the approach that either needed to be resolved or eliminated. He argued that, although the process had led to interesting insights, it had not yet resulted in a coherent vision.

Deployment
The concept of the connected night light was designed in the professional working environment of the team. This made it difficult to investigate the functioning of the prototype in its intended context. For this reason the prototype was deployed for a short period of time at the home of one of the designers.
It was decided to use the sensor and night light to verify whether a door in a studio was closed. The reason the door was used is because the user wanted the door to be closed so cold air could not reach the bedroom while asleep.

The setup of the devices appeared to be an easy task. Unfortunately it turned out to be difficult to determine a few aspects:

- The status of the battery that is connected to the node
- The correct position of the magnet for it to switch the reed sensor
- The correct order in which to connect both the nightlight and the door sensor in order for the system to operate correctly
- The maximum operable distance between the sensor and the night light

Most of these ambiguities seem to exist because of a lack of essential feedback from the devices. A possible explanation for this is the fact that the testing has been done by the designers of the device. Evidently they have an extensive amount of knowledge regarding the prototype and its functions and limitations. This deployment was done in a personal home environment which enabled the designer to interact with the product in a more natural manner through which these problems could be made visible.

Although the deployment was unsuccessful technologically it did prove the power of breaking an expectation pattern. The lamp was used, even without knowing whether it was connected to the door. Once it refused to switch off the first time the trigger was pulled it immediately caused the user to think about several things from which one thought was predominant:

Did I pull the switch?

Other thoughts were:
- Is my door open or closed?
- Is my door connected to my lamp?
- Is my lamp still working?

The objective of the deployment confirmed the assumption that breaking an expectation pattern during a practice is a useful way to ‘hide’ the complexity of interacting with connected products in a home environment. Feedback from the deployment indicated that the product might have too many ambiguities due to complexity of the prototype. Moreover it may not have been necessary to use this prototype to confirm the aforementioned assumption but a simpler prototype that is not as dependent on personal interpretation of the user

The collective insights resulting from these validations triggered the start of the second cycle in the design process. In this cycle the challenge was to translate all the knowledge gained so far into a coherent vision that could be utilized when designing everyday connected things.

Cycle 2

Understanding

Diary Study
In order to take a step back and return to the context of the project a quick and dirty diary study was executed. The participant, an inhabitant of the house where a later prototype would be deployed, was asked to keep a diary for five days. In this diary he described what activities he undertook during the day. He also provided some background information such as what objects were used and why the activity was done. The goal of this study was to gain a better understanding of how everyday life can be defined. Although everyday life was a leading theme during this process, no real effort was made yet to define it.

The most interesting result of this diary study was the observation that over time the descriptions became less detailed and even a bit vague, hinting at the notion that everyday life difficult to describe when not paying explicit attention to it.. Although the first entries included a lot of mundane activities, the latter entries consisted of very specific events that were difficult to classify as everyday life.

The diary study also provided insight into the practices of participant, which could be used during the ideation process.

Expert Input
The start of cycle two was the most challenging part of the design process, as it required the team to restructure all the gained knowledge in order to come to a more coherent vision. This was not an easy task and required an expansion of the frame of reference.
In order to overcome this hurdle dr. ir. Stephan Wensveen, who coached the project, proposed that the team members split up for a week and each focused on a different task at hand. These tasks were: reformulating the vision, developing new concepts and tackle the challenges involved in the deployment of the prototype.

As a result, these three aspects evolved in their own direction, resulting in a wider frame of reference and a broader understanding of what it takes to design connected everyday things.

Vision Development

Complexity of Everyday Life
The research at the beginning of cycle two provided the insight that the missing piece in the developed approach was a good understanding and incorporation of everyday life. This is a result of the ‘invisibility’ of everyday life. But it is understanding and respecting this invisibility that allows products to become part of everyday life. Furthermore, the invisibility of everyday life makes it easy to overlook the complexity that is present in everyday life. Practice Theory [21] can be used to identify and map this complexity by exploring how objects are connected within practices.

Following this it was argued that when connected everyday products are designed they should grow out of the complexity that already exists, rather than introduce new complexity. By doing so systems can be created that are in harmony with everyday life.

This newfound understanding created a coherence in the vision that was absent in the first cycle of the project, and that could be built upon. This resulted in the vision as described in the chapter Approach (see Chapter 3).

Ideation

Connected Everyday Things
Now that the vision was developed, it served as a foundation on which ideas could be built. Following the vision, the ideation process started at the level of practices. With post-it’s a lo-fi ideation tool was developed. Around a set of general themes practices were identified that occur in and around the house in everyday life. Within these practices objects were identified, and the relations between objects were described. Through an iterative process these relations were reinterpreted as digital connections, turning the objects into connected products.

From this two concepts were developed. The first concept utilised the relation between a watering pot and a plant. The plant communicates the amount of water it needs to the watering pot, and the watering pot will fill up with the exact amount of water needed.
The second concept was built on the relation between a letterbox and a letter holder. The letter holder becomes an interface of the letterbox, communicating the amount of mail inside the letterbox. For more detailed descriptions of the concepts see Chapter 4.
In order to consolidate the credibility of the developed

approach multiple prototypes were made that would communicate this vision.

Prototype

Prototype 2: Watering Jar
For both, the communication is straightforward: a node sends out its state and another node reacts to it. In the case of the watering jar, a node is equipped with a soil moisture sensor. The collected data is send to the node in the watering pot. The watering tray is outfitted with a small jar, which is used to water the plants, and a large jar, which acts as a water reservoir. The node controls a small aquarium pump in the water reservoir, which transported water to the watering jar.

The prototype was designed and built to resemble a finished product in order to make it deployable as an everyday thing. To make sure it is as usable as possible the watering jar is designed in such a way that all the individual components could be taken out for maintenance.

Prototype 2: Letter Holder
The letter holder system consists out of two connected products: the letter holder and a letterbox. Because the letter holder is not designed for deployment, the design was kept as simple as possible. With LDR's the system registers when the letterbox is opened to receive new mail, and when it is emptied. The letter holder responds to this by rotating a small servo motor in the base. When new mail is inserted in the letterbox the servo extends the two side boards outwards, widening the object and revealing the mail already in the letter holder. When the letterbox is emptied the servo resets, centering the side boards again.

In order to communicate the concept optimally, the letter holder was designed to resemble a real product and was made from POM (the base) and birch wood (the side boards).

Validation

Deployment
The prototype of the watering jar was deployed in the house where a context analysis was performed in the beginning of the process. The goal of this deployment was to validate the approach defined during this project and to simply investigate the impact of the prototype on everyday life. The prototype was deployed for a total duration of two weeks.
Interesting observations were made during the deployment. An unfortunate event was that the prototype was not functional during the first week, and thus no significant data could be collected. However, the participants did not seem to notice this until after four days, when still no water was deposited.

This might have to do with the fact that the system does not provide direct feedback, but rather visualizes a process that is normally invisible. It is hard to conceive the time it takes for water to disappear from a plant pot, simply because we cannot experience it.

When the system was functional the participants used a small piece of tape to monitor whether or not the system was adding water. Both observations address a need that is not yet realized in the prototype: a clear communication of the state of the system. This is an aspect that was not considered during the design, but seems to make sense. If an explicit connection is created, it is necessary that the system provides feedback that the connection is actually working. This is a design challenge that can easily be overcome by for instance the implementation of indicators.

Although the functional deployment was limited in time, some interesting insights were gained. In a pre-deployment interview about the practice of watering plants it became clear that the practice was a very structured ritual that always took place on fixed times during the week. In the post-deployment interview it became apparent that it was appreciated that the prototype still allowed this ritual to exist. Not only was the concept able to exist in the practice without disturbing it, it even added and enriched the practice by adding a new layer of information. It was proposed by the participants that this information could very well be an added value for users who like keeping plants but have trouble taking care of them.

The participants lived with the functional system for a total of five days. Arguably this is too short for a system is part of a practice that does not happen on a daily basis, and it in the post-deployment interview it became clear that this is too short for the novelty to wear off. In order to come to truly meaningful conclusions and insights, a longer deployment is a necessity. This also allows for iterative updates of the design as issues present themselves.

VI

Discussion

During this project the motivation has always been to explore new ways to approach the design of connected products. The decision was explicitly made to move away from a technology driven process and look for a more vision driven approach. Developing this vision played a key part in the process, and it could be argued that the final design is a vision rather than a product.

Whenever a vision is developed, it cannot be avoided that statements are made. These statements form the foundation on which the vision stands. But the risk in making statements is that they can cause a dichotomy: people either agree or disagree. It is important to acknowledge that the vision presented in this report aims to offer a new perspective. It is hard to argue that it is a 'better' approach, especially since it is still in its infancy. However, this vision was not developed out of thin air, but is built on insights and design opportunities that the authors deemed worthy and important to explore.

The process and the vision presented in this report are not flawless, and there is still much work to be done. As can be seen by the results of the second deployment, further development of the concepts is needed and, more crucially, prototypes need to be deployed over a much longer period of time. Until that happens, it will be hard to compare the presented approach with the status quo.

That being said, the authors do firmly believe that when designing connected everyday things the relationships between the user and the product and the relationships between products should be leading instead of technology. The proposed approach presents a fundamentally different way of exploring these relationships and using them in the design process.

The decision to approach this project within the domestic environment seems to have been the right choice. It provided an accessible way to explore the complexity of everyday life. But it will be interesting to see what impact the insights that have been gained will have when applied to a larger and broader context.

VII

Acknowledgements

Main experts involved

dr.ir. S.A.G. Wensveen (Stephan)
Stephan Wensveen is associate professor in the Designing Quality of Interaction group at Industrial Design, TU/eindhoven. He has an MSc and PhD in Industrial Design Engineering from Delft University of Technology.

His research through design helped introduce notions of ‘aesthetics of interaction’, ‘feedforward’, ‘emotionally smart products’ and ‘wearable senses’. His interest is in personalized products, their behaviours and interactions for the aesthetics of the everyday domain. He is co-author of the book Design Research through Practice.

prof.dr. R.L. Wakkary (Ron)
Ron Wakkary conducts research on interaction design, more specifically in the role of design in everyday practices and speculative reasoning. This includes design strategies to enable customization and appropriation of computational resources and artefacts by everyday designers. He holds the Chair on the Impact of Interaction Design on Everyday Life in ID at TU/e. He is also Co-Editor-in-Chief of ACM interactions magazine, and Director of the Interaction Design Research Centre at Simon Fraser University.

prof.dr. L. Chen (Lin-Lin)
Lin-Lin Chen is Professor and Chair of design and realization of intelligent systems at the department of industrial design at Eindhoven University of Technology (TU/e). She received her Ph.D. (1992) from the University of Michigan in Ann Arbor. She was dean of the college of design at National Taiwan University of Science and Technology from 2004 to 2010, president of the Chinese Institute of Design from 2007 to 2008, and convener for the arts (and design) area committee of Taiwan’s National Science Council from 2009 to 2011. She is the founding editor-in-chief of the International Journal of Design (SCI, SSCI, AHCI), vice president of the International Association of Societies of Design Research (IASDR), and fellow of the Design Research Society. Her research focuses on product aesthetics, design innovation, interactive interface design, and geometric algorithms.

D.A.J. de Roeck, MSc (Dries)
Dries de Roeck is a design researcher at Studio Dott in Antwerp. He has a Master in Product Development from Artesis Plantijn University College Antwerp and a PhD in Product Development from the Artesis University College of Antwerp. He is a part-time affiliated researcher at the Delft University of Technology.

He specialises in design research and (interactive) prototyping. Over the years he became interested in how people integrate and use digital technology in their daily lives and how people with varying backgrounds can be involved in the creation or modification of products that embrace technology. In his work, he loves to walk the thin line between conceptual thinking and creating with focus.

Other experts involved

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Annika Hupfeld is assistant professor in the Designing Quality of Interaction group at Industrial Design at the Eindhoven University of Technology. She has an MSc in Human-Computer Interaction with Ergonomics from University College London and a PhD in Interaction Design and Human-Computer Interaction from University of Nottingham.

She has worked as an interaction designer for Microsoft Research Cambridge in the area of information management, visualization, and preservation. She also has two years of experience working as an interface designer for Siemens Corporate Technology, where she helped design applications and services across a range of business areas, including healthcare, energy, home control, and communication.

dr. M. Selby (Mark)
Mark Selby is an interaction designer and researcher. He has an MA in Design Critical Practice from Goldsmiths College London and a PhD in Interaction Design and Human-Computer Interaction from University of Nottingham. He is an expert at Industrial Design at the Eindhoven University of Technology. He specialises in doing research through design to investigate the potential for combinations of physical and digital materials to help people construct new kinds of value and meaning in complex social, emotional and technological interactions.

He is a co-founder and collaborator at The Institute for Boundary Interactions; an interdisciplinary research collective research working across science, technology, art and design.

VIII

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IX

Personal Reflections

Jip Haarsma

I began the project ‘Connected Everyday Things’ with a strong motivation to make the most of it. The main reason for me to have this motivation was the high expectation of the ability to work together as a team with my other group members.

Initially we concretised our personal objectives as well as the objective we had as a team in the context of a design project. From the start I stated that I had a personal interest in developing the best practice for documenting research, which seemed to me a major challenge in a group project. During the project I learned to quickly read papers, make notes of quotes and important information from several resources. I got familiar with research studies and the principle of building research on other research while following the course ‘Constructive Design Research’. The gained awareness of the principles of (design) research and my personal growth in the ability to put this knowledge into practice contributed largely to my confidence regarding the substantiation of choices during the project.

As a group we had a shared need to use the relevance of the project outcome as a driving force throughout the project to get a good sense of our direct influence on society as designers. This has resulted in a visit to a small IoT conference in Eindhoven which enabled us to get a sense of the current vision on the use of IoT by rising startup companies. We also strive to send an article to a number of design blogs because we believe our insights could be interesting for other designers and engineers concerned with shaping a future world of connected products.

During the project I was perfectly able to utilise my ‘expertise’ in quick relatively high quality prototyping. Next to this I was able to make use of the expertise of my other group members. We complemented each other very well during the entire project. Especially on a higher level, which I believe shows that we are Master students, where we managed to involve expertise ourselves when in absence amongst ourselves and the department. Examples of this are the involvement of Dries de Roeck, the extensive research and the IoT conference in Eindhoven.

Before starting this project it had been a long time since I worked on a design project with a group instead of working individually. During this project I became aware of the great possibilities of working with a team as well as some caveats I had not previously experienced.

Since we are all Master students we clearly have a personal vision of how designing should be approached. I learned that it is important to define a vision as a group while still using the potential of the individual visions to approach the project from a broader perspective. During the project we got stuck in this vision we created for ourselves as a group. At this moment we decided with the help of Stephan Wensveen, our coach, to split up and look at the project from different perspectives.

It is important to avoid making compromises that may bring down the overall level of the project. Instead team members should give input to the project based on their own conviction. From this you can work together as a team to decide which input serves the overall vision of the project best. This approach thus utilises the expertises of each designer in order to be able to decide which input fits the overall objective best.

During the semester I was not always convinced by my own vision on design. Often I felt like I only developed myself on a personal level and my experience with design projects, research and everything that is involved. The assumptional feeling that I did not develop my vision on design along the way later proved to be incorrect. The reason I cannot grasp this development is a shortage of time I need to reflect on how I want to develop myself as a designer and Master student at the TU/e. During my studies I am often inclined to devote almost all of my time to the projects and courses I participate in. I would like to give myself some peace to be able to look beyond my education. For this purpose I have decided to withdraw myself from my studies at the TU/e during my next semester. For now my plan is to pick up my studies after the next semester.

Luke Noothout

Design projects never go the way you expect them to go. It is an insight that is taught early on in design tuition, but it still always surprises me when looking back at projects. You enter a project with certain expectations, and what you end up with might be something entirely else. This project was of course no exception, and it is this factor of unpredictability that I have always liked about design.

After my Final Bachelor's Project I did not study for a semester. Mainly to take a break, but also because I knew that this project would not be offered until semester 2. I was drawn to the project because it focused on meaningful relationships between people and products, something that plays a big role in my vision. I expected the project to be in line with my FBP, a chance to explore a more philosophical side of design and gain more fundamental insights. However, this being a design project I also wanted the outcome to reach a certain level of refinedness. This being my firs Master project, I felt that a certain degree of effort and quality was expected. Luckily I was able to team up with two teammates who shared my motivation and ambition.

My last three semesters I have worked on projects on my own, and doing a team project required some readjusting. Whereas in my FBP I was able to apply and explore my vision into great depth, in this project we needed to strike a balance between three different visions of three different designers. This was not always easy, and required us to find common ground throughout the project. But more importantly, it required us to expand our own frames of reference and be open minded towards insights of others. In earlier group projects in the Bachelor you work in teams in which nobody really has developed strong convictions towards design yet. During the projects the process guides the vision development, and not the other way around. However, Master students often do have a clear set of values that they hold on to and that drive their design decisions. In a group project this means that we have to convince each other of our points of view in order to progress in the design process. Learning to do this and open up towards new insights was one of the most important learning experiences. Creating a vision that is shared by the group is essential, but you do not want to comprise between different believes. Rather, you want to transcend them, finding a new common ground that merges the strong points of each of the visions. Throughout the project it was interesting to watch this process unfold, and it is important to acknowledge that what we have created could not have been created by any of us individually.

The context of this project was very exploratory. Designing Connected Everyday Things is a challenge that leads to vast amounts of uncharted design space. This means that although understanding the status quo is crucial, it will most likely not pave the way through the design process. This is very well reflected in our design process that, at times, was all over the place. Whenever such an exploratory project is executed it is important to investigate as many opportunities as possible, and here the fact that we all have our own way of looking at design is a significant advantage: everyone is drawn to different directions, resulting in a broad frame of reference that can be explored.

However, this exploration is meaningless if it is not translated to insights that can guide a design process. Here our drive to understand the design space as thoroughly as possible allowed us to start making these translations. Our drive to understand the design space as thoroughly as possible allowed us to do this. Instead of simply designing something we wanted to be funded on a larger understanding of what the everyday is, what connected things are, and how these two factors relate to each other. I did not expect that the end result of this project would be a vision rather than an isolated product, but I think this shows the quality and determinacy Master students are capable of delivering.

Looking back I feel like this is one of the best-rounded projects I have delivered so far. It has shown me how a thorough understanding of the context of a project provides a solid foundation on which designs can be built. Even though what we propose is a new approach to designing connected products, I believe that we have been able to substantiate our claims to a significant degree of credibility. In my own projects this is often what I struggle the most with, but this team effort I have learned how to translate understanding to ideation, a valuable insight that will help me propel my projects as a designer.

Bart Versteeg

The project "Connected Everyday Things" is a not only a new project in our faculty, it also concerns a subject that is rather new in the field of design. In my perception, this project is a design/research project that is at the academic forefront of fundamental research on how the future internet will take shape in the second digital revolution. Admittedly, I prefer not to concern myself with fundamental research because I then miss the problem solving, practical and commercial aspect that can be found in applied research. Therefore, one of my primary goals for this project was to take a more application-oriented approach to the fuzzy subject of 'meaningful connected products'.

This desire of an application-oriented approach was shared amongst the multi-disciplinary team. Although originally this was considered a Design project, the novelty of this subject first pushed us deeper into theoretical discussions and desk research rather than fully focusing on designing tangible products. This is something I perhaps appreciate most about our result. We started not with designing but with the development of this vision, which we in turn constantly sharpened by doing iterations of ideation, prototyping, and consulting experts from both inside and outside the university.

However the process of going through these iterations was everything but smooth. The subject of designing meaningful connected products for everyday life is one that has only just been picked up by the academic world. Existing research primarily focuses on the technical and systems aspect of future development of interconnected products and sensors under the umbrella of the internet of things. This means that there was little legacy research to start from. Fortunately, this also gave an incredible amount of freedom to develop our own vision. "Connected everyday things" hovers between interaction and product design on the one hand, and information technology and systems design on the other hand. In the context of the project, I would like to think of our activities as 'designing connectivity', meaning we try to discover how connectedness can be expressed and unfold as an experience that actually fits in everyday life rather than an abstract representation of data.

Because this is uncharted territory it is quite difficult to apply existing ideation methods in the design process. This lack of grip was frustrating because it hindered concept development. Surely many concepts were generated but it was incredibly difficult to come up with concepts that 'felt right' according to our joint envisioned future of connected products. This is the point where we decided to explicate this vision in the form of a theoretical approach or set of guidelines that stimulated the development of concepts we could really stand behind. In a sense, we made our own method. Here, I genuinely felt the responsibility that designers have. Especially because we were working on such a novel subject, I actually felt responsible for our proposed concepts because they would have such an impact of the way we experience the digital world in our everyday life. Therefore, I would only allow concepts that my conscience could agree with, concepts that I can justify not because they are 'nice' but because I genuinely believe they could earn a place in the future.

It has been two years since I have done such a group project and those past groups always consisted of students that were still searching for their interests and expertise, while this group consisted out of Master students who already have incredible experience and expertise. This resulted in a situation where the whole can really produce more quality than the individual, just like is expected in the professional world. The respect and openness towards each other was valued quite high in this group. One of my goals for example was to develop high quality prototypes and although another team member was more experienced in this, there was room for me to carry the design of a prototype with the help of others. In return, I introduced the others to methods of systems thinking, methods of doing literature research and rapid prototyping with electronics and software.

The relation of this project to my field of interest is a very interesting one and became more clear in the final weeks when all our work came together. In the past few semesters, I developed a specific interest for design driven innovation and design thinking. I want to become an entrepreneurial designer who on the on hand thoroughly understands user needs in context in order to create product/market fit propositions, while on the other hand uses his creative and professional skills to bring forward fresh and daring propositions that people will grow to love.

This project does not revolve around entrepreneurial design. Interestingly enough one of the reasons I chose it because I found myself lacking in the tangible aspect of design. Being an entrepreneurial designer means you are often working with models, canvases and system maps but not necessarily with the creation of beautifully designed interactive products. As entre-

preneurial designer you should be familiar with this aspect of design as well in order to understand and work with designers who have made it their expertise. But this project brought me something far more valuable. It showed to me the true meaning of multi competence. As a group we were able to formulate our own vision in an uncharted design space to produce concept proposals and develop them into robust working prototypes in order to experience, debate and validate them. This process is extremely similar to the way an entrepreneurial designer tries to achieve innovation.