Shared resources, calm appliances
Sustainable interaction and care in housing context

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Calle, for his loving presence and care.
Today’s environment conditions have reached a critical stage that challenges us to revert the current paradigm of production and waste into new ways to fulfill needs. The whole society needs a shift away from the individual ownership, being it one big reason of environmental crisis. This thesis project is an exploration into the field of sustainability in housing contexts that seeks a different approach in the matter by encouraging the collective use of resources.

The resulting design is a product service system that uses indeed a combination of artifacts and services to enhance and augment behaviors towards sustainability, by using calm technology as main touchpoint with the users. This means that the project tries to establish a dialog with the user at a level that presents a valuable aesthetic of interaction because of the fluency of communication.
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"In the new era, markets are making way for networks, and ownership is steadily being replaced by access." (Rifkin, 2000:4)

"Exchanging goods is less important than sharing access to services and experiences between servers and clients" (Rifkin, 2000:52)

In the recent years, the society has seen the birth of a new and revolutionary practice, based on traditional methods, slowly disappeared with the increase of industrialization and wealth: it is known as collaborative consumption. The term, used for the first time in April 2007 by author Roy Algar (2007), describes the practice of sharing, lending, trading, renting, swapping, transposed in the 21st century panorama. It basically takes advantage of old-fashioned ways alternative to owning and the use of technology as platform of communication and interaction between people.

This project sprouts from the ashes of another study, the individual project from the first year of this master course. The project in question is Lstrip, an innovative and sustainable way to manage electricity in households, as a result of the observation of how the notion of home electricity hasn’t significantly evolved, but has maintained the peculiarity of being more like a “feature” that comes with the house, rather than an artifact designed for the user.

In other words, the initial frame that led to the development of Lstrip, was the lack of flexibility and ease of use in the current electric home system, that reflects on higher consumption.

Lstrip, shortening for Electrip strip, is an interactive magnetic strip that transfers power to devices, that don’t need anymore a plug/socket system, but just a magnetic plug with a rfID chip, which will communicate to the Lstrip what device is plugged and the voltage needed. It also allows a series of actions directly on the strip (like activating or deactivating a device, act on the lighting system, managing devices in a specific room or area or the whole house) because of its touch sensitive quality, as well as remote control and phone application control. [Visual descriptions of Lstrip are to be found in the Appendix]

By the time I was approaching the thesis project, became more and more tangible the necessity to go one layer up in the scale of abstraction, which in my case was the sus-
tainability scale. To have a visual depiction of this, below is the representation of Lstrip's project qualities, that explains the properties from a detailed and very concrete view (the outer circle), going to a more abstract view, that represents the values and main topics (inner circle). [A bigger picture can be found in the Appendix]

While doing preliminary research, I had the occasion to get in touch with Electrolux and ask if they could have been interested in supporting the development of the project. The answer was positive, so that helped me throughout the project evolution.

Before starting to talk about the project itself, it is useful for the reader to understand a little bit of the personal influences that helped in the direction of it.

My background of studies is in industrial design, while the current focus is on interaction design. Several times, in the development of this project, I have been asked what my role was in it: which is the expertise brought in this? Is it industrial design, more focused in the product and service, with attention to production methods, materials and form (obviously subordinated to users physical interaction), or interaction design, more for the cognitive ergonomy, ease of use, understanding and behavioral response? The answer is rather complex.

I have never been able to see myself as “either or”, partly because the boundaries of these disciplines are sometimes blurred and the spaces overlap, but also because my idea was that having to look at a design problem from slightly different perspectives can be beneficial to the development of a multi layered solution, which will hopefully result as valuable contribution.
The project frame went through a change during the journey, due to the insights gained during the field studies. The initial framing was seeking for ways to improve and enhance current shared spaces that can be found in swedish residential buildings, which currently include laundries and yards, and less often leisure activity rooms, such as table-tennis and guest rooms, to make it possible to share more activities and devices, cutting down consumption. Subsequently, the frame has been changed to improving the design of buildings setting and home appliances in the way that it gives the possibility for users to share resources, while still maintaining the comfort of having own appliances. The context taken in consideration is the project Stockholm Royal Seaport (Norra Djurgårdsstaden in Swedish) (http://www.stockholmroyalseaport.com), a new district with residential, commercial and professional spaces to be built in the next future with a vision of sustainable development and lifestyle. A big interest in this project is in the smart grids system, and sees several construction companies involved, as well research centers, technology companies and the stakeholder Electrolux. For these reasons, the context has been reckoned as a good ground for development of the project, even though by the time of this writing, the construction of the area is at the beginning. Unfortunately it was not possible to retrieve the information on the kind of housing that will be present – whether for rent or sale – but for the project the focus is on the renting apartments (hyresrätt in swedish). The reason

This challenge has generated a possible solution, seen in the pursue of encouraging people to share the use of resources – primarily electricity, water and generated heat – within the community. More precisely, this means that the design consists in a combination of products and services (PSS) to replace the old paradigm of production and consumption. Users will learn how to share resources while still having the freedom of owning appliances, which will be designed to lead them towards a more responsible approach to green living.

The way chosen to convey feedback to the users on the possibility to share resources in a specific moment (that is, when somebody else is already using it), is the kind of non obtrusive one that takes advantage of calm technology. In fact, the feedback given should be a discreet one, which does not force users to pay attention to it, unless they are willing to. This way, the aesthetic value is enhanced, because the quality in the fluency from a peripheral part to the center of the attention is not abrupt, but rather smooth (Löwgren, 2009). Since ubiquitous computing is more and more present around people, it is important to not overload their minds with information that can be not relevant or suitable for the specific moment.

Integrated in the PSS is the service component, which provides useful information on consumption to the user, which is meant to be educative towards sustainability and share. Moreover, the service includes the service provider doing maintenance to the network and single appliances in order to keep it working in the most efficient way.
In the following chapter will be described the final frame of the design question, with motivations and contextualization. It will also include the initial idea for the question framing and, as closing part, reflections around it.

In the 3rd chapter there will be a quick round-up of the methods used throughout the design process, while the 4th chapter will contain the field studies conducted.
The 5th chapter will introduce the reader to the core arguments: the concept of sharing, its design implications and environmental consequences, plus inspirational examples of existing projects. The 6th chapter will instead be more specific on the approaches and directions taken in the project development, as well as an existing constraint – the smart grid system – which will influence the resulting design.

In the chapter 7 the actual project will be presented, rich in the details, with insights from the field studies conducted both with users and the stakeholder. The core aspects will be presented extensively and with references to relevant existing designs that it takes advantage of, while also giving a contextualization with minor ideas for side projects, as well as other inspirational design pieces and reflections.

The chapter 8 will be a reflection on the design knowledge that the project strives to contribute to, with the hope to generate a discussion and increase awareness concerning the topics addressed in the thesis.

The last chapter will serve as final round-up and closing section of this paper.
2.1. DEFINING THE DESIGN SPACE

Several factors led to the definition of the design focus, which has seen an evolution during the process. The space of investigation and experimentation can be defined through the formulation of questions, which the final design strives to give a satisfactory answer to.

The questions that define the space are as following:

- How to improve sustainability in residential buildings by encouraging the collective use of resources?
- How to make the experience of sharing resources pleasurable by enhancing existing behaviors?

The decisive factors for the shaping of the design problem have been encountered during the early research and idea generation stages of the project.

The first factor originated from the reflections generated upon the observation and probing conducted with users, especially those who live in a collective house, based in the outskirts of Lund. From there came the idea of trying to improve sustainability in individual houses in a similar way as it happens in collective houses: by sharing.

The other influencing factor was idea generation session made along with an Electrolux team of professionals in the fields of interaction design, industrial design and engineering, which helped defining the focus even more, becoming the direction of the project the shared brought into the individual, in order to have the same benefit of using something as owning it, but with the social benefit of sharing the same resources. In other words, the shared part is in an early stage of the consumption chain, which makes it more comfortable than sharing the activity and artifact as a whole, but still environmentally sustainable.

As an aid to this, a product service system that takes advantage of appliances that result as being non obtrusive could make put the users in a new position of responsible consumption, encouraging in a collective sharing. The whole journey the user is immersed in will also see the presence of a service provider, that will take care of keeping the system working at its best and augment the experience of sustainable use of resources.
2.2. THE GENESIS

As mentioned in the introduction, to be able to kick-start the project from the ashes of Lstrip, it was necessary of “zoom out” to the issue frame – sustainability – to be able to see what the panorama presents. Of course, sustainability is such a broad theme, so it is impossible to keep on looking at the picture from a far distance, but it is necessary to identify an interesting micro area and start investigating around that, while keeping a fair flexibility on the boundaries.

The initial design space is defined after considering the issues in Sweden of high amounts of electricity consumption (http://www.sweden.se/eng/Home/Society/Sustainability/Facts/Energy).

<table>
<thead>
<tr>
<th>HOUSEHOLD POWER USE (KWH)</th>
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</thead>
<tbody>
<tr>
<td>LIGHTING</td>
</tr>
<tr>
<td>FRIDGE/FREEZER</td>
</tr>
<tr>
<td>COOKING</td>
</tr>
<tr>
<td>TV, DVD, STEREO</td>
</tr>
<tr>
<td>COMPUTERS</td>
</tr>
<tr>
<td>WASHING MACHINE/DRYER</td>
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<td>DISHWASHER</td>
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By observing the above table, it is possible to retrieve data on the household power use and its allocation. The energy consumption for lighting is attributable to the scarcity of natural light in fall and winter; a demonstration to this is that in the worldwide context, only Iceland, Norway and Canada consume more energy for light than Sweden.

Also taken in consideration was the decreasing number of household members in average in Sweden (http://www.scb.se/Pages/TableAndChart___163554.aspx), in big contrast with the population ascension, especially in the three cities with most density: Stockholm, Göteborg and Malmö, where for these reasons, there is need to have smaller living areas. It was exactly this panorama in which the project was starting to take shape.

Being able to tackle these issues from an interaction perspective is complex because the solution can be found in different layers of sustainability, or the coordination of several layers.

As Mankoff et al. formulate, sustainability in interaction design can happen in two instances (Mankoff, Blevis, Borning, et al, 2007):

- In the material design of the artifacts, taking in consideration the energy, waste reduction, re-use;
- In the support of sustainable lifestyles and decision making, ranging from a personal level, to a societal level.
The paths mapped were indeed two, first being a product oriented solution, where the idea was leaning towards smart devices (for example, smart fridge) or smart add-ons, which are those complementary artifacts that help a better or more sustainable approach. The second direction was instead a less tangible one, aiming at taking away the concept of ownership in favor of sharing, in order to cut down consumption. With improvement of sharing, it was intended re-organization of the current housing situation to enlarge the already existing common spaces. It is in fact known that in Sweden about 40% of the population lives in apartment buildings. Most of these buildings have a communal laundry room. (http://blogs.sweden.se/sustainability/2009/11/16/doing-it-together-laundry-the-swedish-way/). The idea was then to add to the communal spaces, areas for activities normally done individually in flats, as for example cooking and recreational acts. That drove me to conduct user observations both in individual houses, but also in those housing systems where there is the greatest amount of shared spaces and activities: the collective house. By having a close look at those two realities, I came about thinking with a different perspective on the initial problem, which was also reinforced by the outcomes of the brainstorming session involving an Electrolux team of designers and engineers. That led to a phase which I named “the big rethink”, after a business conference that sees companies striving to find alternative models to production, in a panorama of sustainability, connectivity, users behaviors, etc.; with design in the first line as tool for change (http://www.economistconferences.co.uk/redesigningbusiness/home). This was the point where the design space got the current definition.

When looking at the panorama of existing designs to raise awareness or cut down consumption, one project in the specific was really interesting as inspiration and reflection piece, for its incredible simplicity in the design and the communication of values to the user. This project has been developed in the Interactive Institute (www.tii.se), an experimental institute based in various cities around Sweden that tries to research in combining design, art and technology in an innovative way. The project at issue is the Power aware cord, part of the bigger research program STATIC! (whose aim is the raise of user awareness about energy consumption in domestic environments), and it basically is a socket strip that communicates the amount of energy travelling through it to reach the devices plugged. Whenever the energy travels across the power aware cord, it lights up in blue, varying its intensity, glowing pulses and flow according to the amount of energy in use.
In this way, the user can have a tangible feedback on something that is usually not shown, causing an increase of sensibility towards the issue of over consumption, but still in a way that is discreetly in the background of attention. For this reason, the cord can be considered as an example of calm technology (Weiser and Seely Brown, 1996), where the design is communicating its values in a tactful and harmonic way; it is up to the user to consciously make a decoding operation to interpret the message, which lies underneath an aesthetic manifestation and needs to be uncovered through reflection. Calm technology will be explained thoroughly further in the text, for its enormous relevance in the thesis project. This project has played a relevant role in generating a discussion around different issues which have been considered in the design framing of the project. First of all, it gave input in investigating environmental topics, with big focus on electricity and home setting; secondly, it maturated in me a consciousness in the benefits lying in raising users awareness on consumption. Eventually, the calm technology nature of this inspirational object turned out to be a fundamental input for the development of one important aspect in the design project, which will be explained in the Sharing and interacting chapter.
The design process has been conducted with a fuzzy front end path. As the name tells, the front end, also called pre-design, appears blurred and wide: it is the moment of exploration, where design and research are not in full distinction. (Sanders and Stappers, 2008: 2) It is also the moment where it is and it should be possible to investigate, change, reframe, focus, broaden the design space.

Of course an initial direction, even if temporary, has to be set; as the case of this project, the share of appliances to cut down consumption, generated from an older project. From there, it is the research, together with exploration, to lead the way to a (other) design space that is defined. As the architecture teacher Quist says to the student Petra: “You should begin with a discipline, even if it is arbitrary […] you can always break it open later”. (Schön, 1987)

So, the framing the design space has been essential to kick-start the whole cycle, even though it was not considered as fixed, but still flexible according to the following phases of the process. Indeed, the field studies, which included users and stakeholders, has given a valuable input on the refinement of the core question of the project, that meant a shift in the design space initially set. The methods used included alternate and joint phases of brainstorming, user studies, stakeholder studies and team brainstorming, as well as a constant background research in the panorama of existing or related and inspirational examples and literature.

The field studies included two sides, which can be recalled as the opposite and interwoven sides of the project: the users and the provider. For the user part, the goal is to gain fundamental knowledge about the usual behavior in
household activities on one hand, and on shared spaces on the other. For the first, several families living in independent houses in the suburbs of Malmö were observed, with subsequent interviews and probing. For the latter, a collective house in the adjoining town Lund has been the core of information retrieval.

For the provider the objective was having an overview of the stakeholder Electrolux, essential for the understanding of their mission and image to the consumer, and also to know which is the threshold of possible and areas for challenge of their perspective.

The idea generation phase has seen brainstorming sessions, mostly on own, except for a team brainstorming conducted with a team of designers and engineers from Electrolux.

### 3.1. Sketching: the vehicle of thought

Fundamental for the whole length of the life of this project, has been the use of sketching, both to brainstorm ideas and convey information to the supervisor, peers, users and the stakeholder.

During the shaping of the project, reflections, possibilities, inputs from the field studies, all has been processed with sketching. It was not just aiming at presenting to others, but it was the medium through which my thoughts took shape, thus made the reflection in action possible (Schön, 1987). By sketching, different alternatives are considered, choices are made and implications subsequently visualized. Every alternative, every single moment, has derived implications; those, in turn, will have more implications originating from them, and so on from the holistic view to the details. This is called also the “What if?” actuation, from exploration to direction-taking, to evaluation. And, as for every shaping process, it is fundamental for bringing in a clear view, the path that led to the final point; from there, it is possible to move in the design space, to focus or broaden the scope, to reframe the question. As stated in Chapter 2, it is exactly how the events unrolled for the project evolution, from a starting design space, to a reconsideration and consequent reframing.

Furthermore, it was exactly with sketching that the phase of idea generation and materialization took place, fed of all the previous experiences – the user studies, the research, the team brainstorming – that served as grounding for the reflection in action. Ultimately, the sketches were used to communicate the concept, to convey the values of the project and possibly engage in a conversation (Buxton, 2007).
FIELD STUDIES

The field studies include both observations on users and investigations on the stakeholder. In this chapter will be elucidated the methods of conduction of the studies and the interesting insights and reflections generated from them.

4.1. On user studies

The user studies involved rounds of observations during the act of accomplishing relevant tasks to the research, interviews to clarify and reveal users thoughts on specific issues and situations, and cultural probes, to gain a deep understanding of users views and perspectives, thoughts and expectations. The users were belonging to two different categories. The first, of the typical family with kids, living in an independent house and with a car, not so concerned about green behaviors as opposed to increased comfort. This translates in a series of not carefully planned acts that have been observed and considered interesting for further research. The latter category is the one composed of people living in the opposite way, which is the collective housing alternative. 25 households placed in the outskirts of Lund, with people sharing a huge amount of space and activities, among which dinners every second day. Obviously these two groups had very different visions on household activities and ways to deal with them, enough to emphasize important aspects that were later brought as starting points to an idea generation session with a team of Electrolux professionals.

4.2. Probing. A short introduction

Probes can be defined as "... an approach to user-centered design for understanding human phenomena and exploring design opportunities" (Mattelmäki, 2006). They are tasks crafted ad-hoc for every project, fulfilled by the users, to give the designers an insight on their personal perspective on things. Probes make their entrance in the design world in 1999, from a team of designers composed of Bill Gaver, Tony Dunne and Elena Pacenti.
In order to gain good understanding of the design area, the users were given probes to work with. They are a powerful tool to stimulate designers’ sensitivity and start a sparkle to the idea generation; it is not a scientific practice, quite the opposite, they require subjective interpretation, but at the same time provide a more empathic view of the user.

The probes consisted in a small notebook where it was asked to self monitorize the user’s actions while engaged in activities central for the project. At first, it was asked to choose among the transportation method used to take food, and how many times in the set time lapse (5 meals). Subsequently, the users were asked to sketch their kitchen setting and how they moved in it when preparing food. This was aiming at observing how many times people went to the fridge, the oven, and other devices. For the laundry part, users were asked to say how many baskets they did per session, and how full they were. Lastly, they were supposed to check in a yes/no form if they dosed the soap and used the same program for all washes.

The users had the freedom to fill all the parts that felt appropriate and for the time they felt most comfortable with. This choice of high freedom, turned out to be good and bad at the same time: those who got back with the probes were really happy to contribute; the others didn’t get back at all. That made a result of 2 probes returned and 2 still vacating. [The probe booklet can be retrieved in the appendix]

4.3. Independent houses

At this stage of the project development, the frame was still blurred and has been changed as a result of the field studies; for this reason the studies conducted with independent household were focused on different activities, even though they resulted just as good to give understanding of some user behaviors regarding sustainability at home.
The three houses visited are located in the peripheral areas of Malmö, where most of the independent houses are, for obvious space constraint reasons. The first family observed is composed, as well as the other two, of four members:

- Ane and Ralf, in their 40s, creatives;
- Nina and Bengt, 9 and 6, going to primary school.

Ane and Ralf have an independent house and a car, as well as bikes for each family member. They use either car or buses to move around in the city center, since it is quite far from their house. The car is also needed to take the kids to school and then back, so one of the parents, interchangeably according to their schedules, will take care of that.

The second family, neighbor of the previous one, has:

- Katrin and Martin, also in their 40s, owning a small design firm;
- Two teenage girls (who did not attend the session);
- A dog, which lives indoor.

Both of the parents work in Lund, so they take the train everyday, while the daughters attend schools in Malmö.

The last family living in an independent house has again four members, which are:

- Patrik and Agneta, around 40 years old;
- Two twin sisters in their pre-teens;
- A small cat, living mainly indoor.

Patrik and Agneta live very far from the city center, which is where their job is; despite that, they like to go to work by bike when the weather is good, meaning a 7 km ride, twice a day.

They have been observed in two main household activities: the preparation of a meal in an ordinary day, and the activity of doing the laundry. During those moments, an interview/dialogue was conducted, to better elucidate some actions or to ask for behaviors and perspectives on the general topic of sustainability. After the observation, a booklet of probes was handed.

The results of the observations revealed some pattern that the participants that took part of the research have, helping to define potential areas where further investigation and studies can be conducted. Lunch is usually consumed outside home, for the different activities in which the family members are involved, except for weekends; for this reason, it seemed more appropriated to have the observations on normal working days. In an ordinary weekday, where both of the adults and their children are busy with jobs and other activities, these families tend to have simple dinners. That is the time when one or maximum two courses are served, and usually only one person is in charge of preparing the meal. This is the consequence of both a busy schedule in the family, so that one member
of the family has to necessarily take care of other household activities, being it laundry, tidying up, looking after the kids; but also and not less importantly, of the limited space plan, that allows only one person to move comfortably in the cooking and dining area. In general, the participants observed tend to be more or less approximate with their actions, being the time constraint an important issue.

By observing the participants, it resulted to be more important to have a sustainable behavior after the food has been prepared, rather than before as well. This means that, all the activities and small actions done to accomplish the task of preparing food, can have a quite wide range of tolerance. In other words, the whole flow is not planned or organized, but rather improvised without considering some logical behaviors that could make a difference in an ecological point of view. Starting from the moment of buying food, it emerged how it is not an activity considered in a time-wise or sustainable way, going to food stores often and with cars. Of course, the fact that the trips were very frequent, makes the hypothesis that those were not heavy loads of shopping, thus didn't require the car. In addition, the places of shopping were also reasonably close, enough to be reached in a 10/15 minutes' walk, or even shorter bike ride. These observation, even though not closely related to the project, give a picture of participants' mindsets and behaviors.

During the actual meal preparation, in separate occasions the fridge has been opened, many times just to find inspiration or to take or put back in place only part of the things necessary. Even though all of the fridges of the participants were well organized, it was not enough to make them avoid opening them for too long or too many times. Agneta for example – which has been observed in the last batch – cooked a dinner following a recipe: even though she had the list of needed ingredients, and is well aware that opening the fridge too many times is a wasteful activity, could anyway not help going back and forward to the fridge. Another situation observed has been at Katrin and Martin's place. When the dinner
was almost ready, one of the daughter enters in the kitchen and goes to the fridge, opens it and says to his father: “Look dad, today I bought juice!” This started a short conversation, all of it in front of the juice inside the fridge.

Surely, in both cases the activity turned out as being equally bad, no matter if it was more or less necessary, or just very superfluous. Some people are aware of it, some not, but in my opinion based on the observations, in the end it turns out that the fridge is designed in a way that can not avoid the issue.

Another singular behavior observed, is the logistic problem that some of the participants have been experiencing: two different dishes, which are supposed to be ready at the same time, ended up being ready with a 10 to 15 minutes gap. Ralf, for example, emphasized the issue by saying: “I would like to have all the food ready now, but how to fix this logistic problem?”

The reaction to that has been to put the food ready in the oven, turn it on at a middle temperature, and wait for the other dish to be ready. It is arguable how warm an oven can get after only 10 minutes, maybe not enough to make a sensible difference. Same happened to Martin, that preparing food for the family and a guest, had the problem of a too small pan to cook chicken in. Again, after the first batch of chicken is ready, it goes in the oven waiting for the second batch to be done. It was, in both cases, an improvised activity as remedy to the problem, rather something done with quite some familiarity, as if it happens often. Thing that has been confirmed by the cooks during the observation.

After the dinner, all the participants reported to clean dishes with the dishwasher, but only if it reached full capacity. Automatic wash is known that to be less water consuming than hand wash, as long as the machine is activated only on full load and is a fairly recent model, which consumes less (http://www.treehugger.com/files/2005/08/dishwasher_vs_h.php).

What about the laundry? The conclusion is that having all the appliances to clean and dry clothes always available (unlike the usual flats in condominiums), made the participants use them very often. All the families interviewed, which have a number of 4 members, reported to do a wash a day in average. The observations revealed that the loads are not always full, unsurprisingly, considering the quantity of clothes that can be put in the basket per day.

The activity of laundry is also conducted in a fast and thoughtless way: the participants showed to not dose the soap for the washes. Many of them revealed that they don’t know where exactly to put the soap, according to which moment of the washing cycle (pre-wash, wash, softening), and also don’t bother dosing it. When Katrin was putting the soap in the washing machine, she started pouring the soap in all the compartments. When I questio-
ned the reason of the action, she just replied: “I did it because I don't really know where the soap is supposed to go, so I just put it everywhere [...] I know I could spare maybe half of the soap if I dosed it, but I just don't do it”. So then the reflection out of this is: is it really helpful to design packaging for soaps that aids the dosing act, as it happens now? Why is this problem not tackled, or at least not by many, in the design of the washing machine instead? This is surely very impactful in the long run, both economically and ecologically.

The observation and probing of independent house families gave a fairly unhappy picture of the situation, with comfort preferred over sustainability. It seemed more an issue of taking away a behavior that can't easily be changed in favor of a little effort to avoid over consumption.

The following stage has been then to visit the collective, which presented quite some differences from this part of observations.

4.4. The Collective

4.4.1. What is cohousing?

Collaborative housing, or more commonly cohousing, is, like Susanne Grolle defines, "A lively, local, mixed-use settlement on that maximizes the quality of life and social interaction while minimizing negative effects whether social or environmental, thus benefiting both local residents and society at large", and "form of intentional neighborhood in which residents actively participate in the design and management of their own community" (Grolle, 2008).

Cohousing was born in Denmark in the 60s, where now is how 5% of the population lives, and successfully spread worldwide (http://cohousing.org.uk/).
4.4.2. Fiolen

The collective visited is located in Fiolen, a residential suburb just outside Lund city. It was established in 1992 and has 24 flats, with size varying from 2 rooms to 5 rooms. In there, live people with ages from 1 to 70 years, and with different nationalities as well. I was introduced by Päivi, a lively woman in her 40s, originally from Finland; with her I had the possibility to see the collective locales and have an observation session during the preparation of a shared dinner.

The house is owned and maintained by Lunds Kommuns Fastighets AB (Lund's municipality real estate, mentioned as LKF further), and was designed with the tenants, some of whom still live in there.

The individual spaces include, for all households, an ordinary apartment with all the facilities (except the laundry) and also either a small garden or a balcony.

The area of sharing includes a big living/dining room, a kitchen, laundry, pantry room with food storage, a guest room with TV, a room for young kids, a recreation room and a sauna. Moreover, there is a small greenhouse and a yard. LKF takes care only of the extraordinary maintenance, while all the ordinary maintenance and cleaning is up to the community, which is organized in shifts for all the activities.

The dinner, that is shared every second day, has three to four chefs, which will make a proposal of the dish cooked for the day. If the dish includes meat or fish, they will also have to make a vegetarian variant. People living in the collective will have to sign up for the dinner – which costs according to age – mentioning also if they have the intention to bring guests. The chefs will also take care of giving an alternative or adapting their recipe in case any of the diners might have allergies or intolerances.

At the end of the dinner, two people (different from the ones that cooked), will be doing their shift of dishwashing. Every person is expected to cook food twice and clean the dishes three times a month; the rest of the times they will just enjoy the meals without any tasks to accomplish. As Päivi says, everybody is happy about the communal dinners, because “…Most of the times, you don't
have to think about anything, you just come here and eat!".

The laundry works just like the ones present in most residential buildings in Sweden: a booking system allows the tenants to use the room for a predefined lapse of time.

During the observation, I had the occasion to observe a participant doing her laundry, which was good and bad at the same time for different reasons: in the moment of putting soap in the washing machine, she did not dose it, ending up using much more than needed. The same participant could not fill a whole drum, so just went away with the dirty clothes, waiting to be able to fill it up.

One of the most interesting things from the collective house study, is not in the organization or the structure, but in how people have built an inner network, a small community or mutual use and help: in the dining room, people is used to put things they find not useful anymore on a table; there anybody is free to take it. Participants reported how several kids shared the same clothes from the eldest to the younger ones, just because their parents put the newly small clothes on the table for others to have. This was a big moment that revealed how it is not fundamental to have the last energy efficient appliance – though that helps the environment anyway – to make people adopt a sustainable way of living.

The other rooms are commonly used without any problems by the people together, who enjoy having side activities other than the scheduled dinners. The care of the outside garden is also organized in shifts, and everybody is expected to work 8 hours per season, which can roughly be defined as two days. It is an activity that the people enjoy having together, unlike the dishwashing where only two at a time are needed.

You can breathe a big sense of community in Fiolen. Everybody has tasks, and everybody is well disposed towards them. Coming from this, a high sense of trust and a lot of flexibility. For example, if someone has difficulties being part of the responsibilities coming from the collective for some time, it will not be a problem for the rest of the community.
4.5. Reflections on user studies

These observations, interviews and probing, revealed a lot about how people see household activities and behave towards sustainable issues. Mainly, having two categories of participants, which in many ways can be considered as opposite, generated a deep reflection around the idea of sharing. It seemed as collective spaces did not need more improvements, but rather the individual places constituted the problem, or better said, could be a more interesting and challenging framing for this design project. From these reflections, fundamental inputs have been brought up to the brainstorming session with Electrolux, which will be explained in the next section.

4.6. Electrolux

Electrolux has been present and updated in the development of the process, mainly by emails and phone, as the distance made it impossible to have a face to face interaction. Besides this, it was not until almost half of the project time length that Electrolux really had a decisive impact on the project. The proposal to have a brainstorming with designers and professionals from other areas was welcomed as a good one for both sides, where the company could possibly benefit of a project that is not outdated or simply just useless, and myself as having a solid thesis and a design that is portfolio-worthy.

The plan was to leave up to me to decide how to conduct the workshop, propose the directions, set the pace, while the Electrolux team would be active and responsive and why not, even critical if felt as good input.

At the workshop participated 6 people, including one of my contacts, Petter. The team was composed of two industrial designers, two user experience designers and two advanced product developers.

The mix turned out to be really efficient in terms of completeness of ideas, inputs, etc.; that is because everyone added a different point of view, due to their background and expertise, but also knowing different sides of what the company is interested in and which fields are thought to be inspirational.
The flow of the workshop was structured in an introductory part, where all of the participants presented themselves, followed by a round-up of the project, the research and user studies done. The core part had the representation and discussion of the findings; that is what, in my opinion and considering the initial design space previously set, was thought as issue or interesting observation to reflect and engage in a discussion. These findings were shown as a projected presentation, as well as sketching and pictures from the user studies, and lastly, with the probes that users filled in.

This indeed generated a brainstorming of ideas around the design space of sustainability and sharing, which turned out to be a bit refined and reinforced to “bring a little bit of the collective approach to flats and houses”. All the ideas were written in post its that were put on a big paper, where previously the pictures with interesting findings were put on. This way all the participants could easily see the ideas from each other, in order to visualize how the space was taking shape. These ideas and proposals were lately organized by similarity and correlations, and again read all together to have a complete vision of the brainstorming and possibly give the chance for last inputs.
This chapter will explain how sustainability can be a central topic within interaction design, choosing a valid set of values, methods, reasoning and research to accomplish the task (Blevis, 2007).

5.1. A sustainability introduction

“Sustainable design is a philosophy that seeks to maximize the quality of the built environment, while minimizing or eliminating negative impact to the natural environment”. This is the definition that McLennan (2004) gives in his work.

The fact that the whole world is constantly facing the downsides of centuries of productivity without care for the environment, brought sustainability up to the center of discussion in many areas, one of which being the design area.

As Papanek noted more than fifteen years ago, in the 21st century, design will have to be adopting a whole new perspective: “Designers and manufacturers will need to question the ultimate consequences of a new product being introduced. Questions on profit balances and production quotas are not enough” (Papanek, 1995)

The business and economy axioms in the Western world have gone through a massive change over the last decade. Where before almost the entire economic system was based on manufacturing, now 60-70% of the GDP (gross domestic product) is allocated to the service sector (Erlhoff and Marshall, 2008).

Still, it is not enough to justify the enormous quantity of waste that keeps on flowing from the production chain, to stores, to houses and then discarded: 99% of that material only lasts for 6 months. That means, that only 1% of the produced items has a long life (Leonard and Conrad, 2010). But how long? Before answering this question, it is necessary to do a short premise.

After the Second World war, in America, the government and business corporations sat down trying to figure out how to revive the economy, that obviously reflected the situation in the context. As the economist Victor Lebow explained: "Our enormously productive economy […] demands that we make consumption our way of life, that we convert the
buying and use of goods into rituals, that we seek our spiritual satisfaction, our ego satisfaction, in consumption... We need things consumed, burned up, replaced and discarded at an ever-accelerating pace" (Lebow, 1955). That led to a strategy to make this flow of production-consumption faster: obsolescence. It can happen in two different ways, one implemented in the product, the other, more subtle, nests in the society. The first kind, planned obsolescence, is the design strategy that makes the product last for a defined time range, which is shortened by quality of materials, ways of production and design form, etc. For example, avoiding the product to be possibly repaired, or swap only the broken component is an example of how the lifetime of a product can be sensibly decreased. The second kind of obsolescence is the perceived one. It is a matter of styling and fashion mostly, which makes a product look old without actually being less efficient than the new sleeked-up version (Leonard and Conrad, 2010). At the same time, media bombs us saying that the phone you bought last year is “old”, thus not good anymore, influencing the masses in compulsive shopping. Sustainable means reverting this process, pointing more than ever at services and PSS, producing not for quick obsolescence but long lasting items, using less pollutive materials and encouraging and promoting local business and the access over ownership. This way, the cradle to grave can change to cradle to cradle, where the materials that form a product are non-harmful for the environment and can be used over and over instead of being down-cycled and ultimately wasted in landfills (McDonough and Braungart, 2002).

5.2. What is sustainability within interaction design?

Interaction design can be considered as the bridge in communication between humans and between humans and an artifact (Saffer, 2007). It is quite a broad definition, but it gives a good picture of what interaction design involves. It would be restrictive to say that interaction design lies in the object itself, and also in the conception and understanding of it from the user side. Rather, both of them contribute to it, but the interaction happens when the user is engaged with the artifact (Dourish, 2004).

It is often referred to sustainable design as a material or technology improvement, but when we talk about sustainability within the context of interaction design, the matter is more subtle. That is because what is designed is not necessarily something tangible, but what happens when the user is in the act of engagement with it.

That brings up a series of aspects that the designer has to consider in order to have the user interacting with the artifact in a sustainable way. How the artifact is perceived, what is its presence in the context both in use and not, the understanding of it, are just some of the things to be considered. Sustainability within interaction design means having a user-artifact system that works in a seamless co-ordination that is less harmful for the environment.
5.3. Collaborative consumption

In the last decades the world has seen massive technological innovations, but at the same time started experiencing huge environmental problems. By observing the past events in society, it is evident how there are high peaks of social innovation in moments when there is either new technology spread in the population tissue, or an acute and urgent problem (Manzini and Jegou, 2008). The result is, just like observations made in the past, a wave of ideas that fall into the space of social innovation, that aim at improving local collaboration, mutual help and assistance, equipment use optimization. All of these factors influence positively the reduction of the need of products and living space for each individual, with a decrease of environmental impact, while improving social relations: this is the innovative way of collaborative consumption. It has gained formal entity in 2007, after Roy Algar wrote an article about it (Algar, 2007), but in truth is a traditional practice that has been always used by humankind, until wealth came, and with it the need to own and identify self with objects (Mullane, 2010: 4,5). In the next part of the chapter, some examples of this 21st century version of old practice will be explained and analyzed.

5.3.1. Welcome to Manzini’s

Ezio Manzini is one of the most important names in the emerging field of collaborative consumption. His essays and books are collections of innovative solutions generated from seminars and workshops with professionals and students in the design sector. The book written by him along with François Jégou (2008), is the result of two years of studies with universities, research centers based in Europe and other institutions in the EMUDE project (EMerging User DEmands in sustainable solutions) with European Commission co-founding. The result generated is promising concepts, in the way they tackle the problem of over-consumption of resources by trying to combine creatively what is already existing, without waiting for the whole production, economy, institutions etc. to change their system. To be able to reach this goal, the concepts generated takes advantage of some basic solutions, which can be retrieved in traditional methods, when the status of people was not as high and the act of share was an everyday practice. These solutions are, in simple words, bottom-up initiatives (Stø, Strandbakken and SIFO, 2008) where is indeed the community that starts and actuates the innovative design, which has as main point the social aspect, rather than the technological solution or the marketing strategy.
5.3.1.1. Multi-user laundry

The idea included in Jegou and Manzini’s book (2008) is called Multi-user laundry. It is a laundry room equipped with two to three professional washing machines especially designed for collective use. These washing machines are made so the optimization of consumption is at its maximum, by running only at full load. Because their capacity is of semi professional washing machines, they are supposed to be used simultaneously by different users. Everyone will have netted bags where to put their laundry, so they can get clean without mixing with the neighbors clothes. The internet booking system will allow people to book a place (or more) in the washing machine, which relies on a pay per use system. If the full load is not reached, it is possible to express a preference on when to have the laundry done, so the washing machine will send a notifications to all the neighbors to encourage filling the available spots for washing.

This is an example of collaborative consumption stretched to the point that the design of the product which the PSS relies on, does not contemplate any other use – the individual one. Also, the online booking and availability notification increase the value of contributing to a reduced consumption.

5.3.1.2. Open handyshop

One outstanding example from the aforementioned book is the Open handyshop. At first look it is just as a common hardware/tool shop, but instead it is much more than that: it has a workshop area provided with tools, where a professional – the owner – gives assistance with DIY (do it yourself) tasks, checks so everything is working and positioned at the right place, and that users keep the space clean after them. It gives the possibility to avoid buying (expensive) tools that will only be seldom used – and most likely be occupying space in the basements – have a good space where to work, set up with all the necessary, have the possibility to buy needed materials in the same place, and get assistance from a qualified and reliable person.

This is a good example of collective share, where everybody borrows the workshop’s tools
to accomplish the task they are aiming for, and also the value of accomplishing the task rather than owning the tool. As Dourish (2004) would say, the importance is on the "ready to hand", which means that the object in use disappears from people’s cognition because the focus is in its meaning, the accomplishment of the task, as opposed to the "present at hand", when the physicality and the presence of the tool is the focus. The enhancement of the ready to hand concept is fundamental in this project, as it will be explained further on.

5.3.2. Zipcar

Several examples have sprout internationally and locally, some with business and others with social acceptions; both of these sides are noteworthy and inspiring for a conversation around the topic.

One of these projects, surely among the most successful in the business area, is the Zipcar automobiles service company. Zipcar is the biggest car sharing system in the world, born in 2000 (www.zipcar.com) and operating in America, Canada and the UK, with a community of "Zipsters" – this is the name for the service subscribers – that counts 560,000 and 8,000 cars (http://zipcar.mediaroom.com/file.php/158/Zipcar+at+a+Glance_Media+Kit.pdf). Impressive to think that the proportion of 1 car every 70 users is still good enough to please the demand.

This either implies a wiser use of car from the zipsters, that will turn to the service only when really necessary, possibly trying to join more tasks in the same lapse of time to optimize the use, but also less traffic, less pollution, more space.

One of the most important features, is that cars are spread in the whole territory where zipcar operates (over 60 cities), so that it is possible to use the zipcar smartphone application to simply browse in the desired geographical area for available cars and pick one, or request a car in a desired location. The booking can happen months ahead, or even just minutes.

Even companies can rent Zipcars, which is something that will surely benefit the finances and give a good perception of them either among the employees and clients, and the rest of the people.

Also, campus students and teachers can access the service with a special price fare, and will always have cars
parked inside the campus for quick and easy access. The enormous success can be retrieved in the motto “keep it simple”, as the Zipcar CEO says (http://www.openforum.com/idea-hub/topics/innovation/video/learning-from-the-pros-zipcar): having such a complex structure of car rental and a massive number of subscribers makes the whole system vulnerable in actually revealing this complexity to the user, becoming a not so pleasant to use service. It is thus important to analyze carefully every touchpoint and have it as simple as possible in the frontstage, by having the user being able to access a car 24 hours a day, 7 days a week, without worrying about fuel and insurance, as well as being able to have high personalized service (www.zipcar.com), by choosing the subscription plan – as occasional driver or frequent, as private, company or student/teacher – the car model, and the time of use, varying from hourly to daily.

The benefits are several: money saving, flexibility and freedom from all the commitments that an own car implies. Plus, the company strives to communicate and make the users feel as part of the green community, as main actors in the process of social change with sustainably correct behavior (http://www.zipcar.com/is-it/greenbenefits).

How interesting to see a company succeeding in the de-materialization of the product, making the actual identity of it something that is not in the frontline, but the need and use of it (the Service) the value communicated. Still, the “need” of having a nice car to impress the boss, can be pleased by communicating the choice in the booking process. Surely, still more convenient than purchasing an own expensive car only for occasional show-offs.

This project is a good example of sustainability behavior. It is indeed not the product to change – the cars are the same that can be found on the market – but it is the behavior that people are encouraged to have that makes a common occasional car driver, one that owns the car, to a responsible one, that rents it out whenever attentively considered as needed, trying to organize time because it is limited, to hourly or daily lapses. The proportion stated before of 1 car every 70 zipsters, implies a collaborative use of those cars, where different users in turn make a reservation for one of them, either by special needs (big spaces, status) or by practicality (the closest to the starting point location). In the end, it is a collaborative consumption solution, which the users are aware because of the image that the company wants to give of its subscribers, the zipsters, a community with good sustainable behavior that together is working for greener environments.

Moreover, it is not only the product being offered – the cars – but the service around it, which includes the gas and insurance, the booking system, the maintenance, the customer service.

In short, it is possible to state that the sustainable goal is reached through a product service system that implies collaborative consumption.
5.3.3. Sharesomesugar.com. “… You can knock online instead”

Share some sugar is a web based community that allows people to share or borrow things from the neighbors. The project was born in the U.S. in 2009 to contrast the necessity to buy items when they are not used with high frequency, which will helplessly end up collecting dust in houses. It has a simple search engine to look for the needed item and set the preferred location; the results will show who has what, and if they ask for a rental fee. The idea is born 3 years ago from the experience of Keara, then 23 years old, which moved to a new house. Suddenly she realizes she is missing a lot of tools, but also is aware that somewhere in the neighborhood, somebody has exactly what she needs. This is the reason that leads to the website creation, to encourage people to join the community, where just like the old days when it was common to knock at the neighbor’s door, “… you can knock online instead” (http://www.sharesomesugar.com).

This is a relevant example because it is a demonstration of how emphasizing the importance of keeping the society’s fabric tight, can benefit the individuals in everyday life; moreover this good disposition between people will also benefit the environment.

5.4. Reflections

This chapter served as a reference for the reader by providing theoretical foundations for the project and some valid examples in the direction of sustainability and collaborative consumption. These above mentioned projects present some common points, as well as differences. Share some sugar is a community that sees private people opening up for collaborative share and consumption, where the two actors involved in the process – the lender and the borrower – both take advantage of the situation: the first can ask for a renting fee, while the latter will not have to buy a one-time-stand tool. Zipcar is instead an example of the shift of focus from product to service of a business company. This represents a big example in the opening for new economic opportunities for companies, which can and should reframe their business methods towards new paradigms, which will have positive results on the environment and the community as a whole.

The example of the Open handyshop is something that can be considered as in the middle of the other two, being it partly a business (the shop where to purchase items) and a free-service offerer, which makes it a social and community aggregator. The multi-user laundry is still something coming from a bottom-up sparkle, but it still has some business side attached to it: it is not just a share and swap, it is the use of a service through a device, which necessarily needs a starting investment and maintenance, and thus it falls into the business. All these examples give an important background of how small local movements can be a good remedy to unsustainability, mostly relying on what is existing and can be improved, and very importantly, on more responsible behaviors.
6.1. Service design

"Services are a series of interactions between customers and the service system through many different touchpoints during the customer journey" (Stickdorn and Schneider, 2011: 80)

This definition is what service can be considered on an interaction design point of view. Service design is a fairly new object of studies in the field of design, and for this reason there is still a quite blurred definition of what it is and how to approach it in a designerly way through objective methods (Mager, 2008, Stickdorn and Schneider, 2011: 15-16). It would be very complex to give service design a fixed definition, being it interdisciplinary; however, several approaches are shared among these disciplines, and those are the one that will be described in this work, because closely related to the nature of the project.

Services are intangible, cannot be stored, and happen only in co-creation with the users: without them, the service does not have any shape, it does not exist. A service is shaped together with users, which are part of the production process as well. This is possible because the service is a process that is “produced” and “consumed” concurrently and it only exists by the time of use. A service is the result of the collaboration of many actors, involved to provide the service to users. The part that the users perceive of a service might be considered as the tip of an iceberg, because they only get a partial picture. In truth, there is a whole system of people and artifacts that work to maintain the service alive and in good shape. These two worlds are distinguished between “frontstage” and “backstage”: the first is the visible part, the one that has some sensorial essence – being it visual, sonorous, olfactory, tactile – so that the user can get concrete awareness of. The latter, also called “back office” is instead the hidden network, the coordination between humans and machines that works as a structure, a foundation for the frontstage (Glushko and Tabas, 2008). The separation between the two stages is called “line of visibility”. In the frontstage part it is possible to see the line of interaction between the service personnel and the users: those are the moments when the service is actually happening. Below the line of visibility, there is the interaction between the supporting processes and again, the personnel: that is the internal interaction line (Zeithaml, Bitner and Gremler, 2005).

An important design tool for the design of services is the use of customer journey map-
ping. A customer journey is the set of all the interactions of users with services in a time-line (Miettinen and Koivisto, 2010: 15). It is a mapping of a persona using the service, exploring all the touchpoints. A customer journey is a powerful construct to analyze a service in with different methods, systems and visualizations; it helps seeing the big picture of the service as a whole, while still being able to study all the touchpoints singularly and in a chronological sequence.

To make services valuable for users, it is fundamental to understand and analyze all the interactions they are involved in during the use of the service, which is possible by trying to see the service with users eyes, and at the same time think as a designer to give a valuable experience (Stickdorn and Schneider, 2011: 80), meaning that it is necessary to consider what happens in the whole picture, both in front and back stage.

6.2. Product-Service system

This is a field where interaction design is a fairly new presence, and unfortunately for this reason the literature that analyzes the topic in this perspective is very poor. However, product-service systems have a lot in common with services, and for this reason, all the notions explained in the previous section serve as good tools for the design of PSS. A PSS is a set of products and services that work together to fulfill users' needs. It can either be product(s) with enclosed services, or viceversa (Goedkoop, van Halen, te Riele and Rommens, 1999), and the proportion of one as opposed to the other is highly variable and can change over time. Unlike products, users, manufacturers and providers shape the PSS together, by coordinating needs and fulfillment. An important factor in PSS that the design needs to consider is the time quality: the service is produced and consumed over a lapse of time that can be overlapping and looping, modifications over time and external factors can influence and reshape the PSS (Morelli, 2002a). For this reason, the designer needs to organize the flow of events through a scenario representation - just like it would happen in service design - where the customer journey is mapped taking in consideration all the touchpoints and the actors involved: technological components, personnel, customer relation and communication.

6.3. Calm technology

The home setting is a relevant context for interaction design, because of the huge presence of ubiquity. It is necessary to briefly introduce the concept of ubiquitous design to give a fair background and knowledge around the project and the choices made during the whole development process.
In the beginning of the 90s, Mark Weiser, in charge of the computer science lab for Xerox Palo Alto Research center, envisioned a notion that was really revolutionary for the time: it has been known since then as ubiquitous computing (Weiser, 1991). According to Weiser, the evolution in technology would be able to "shrink down" computers – both in size and price - in a way that is not necessary anymore to have only a central one, but to make it possible to have many decentralized artifacts spread out in the environment, that present a computation enhancement. He also argued that 21st century computers will be so present and embodied to become something that users take for granted and lose awareness of their presence. As in the Little Prince novel, “The essential is invisible to the eyes”.

More than 20 years later, it is possible to say that Weiser was right: in today’s smart homes there is a massive number of technological devices, and it is almost impossible to be aware of all of them, sometimes because they are intended to be invisible (movement sensors, etc), and others for the gained acceptance in users lives (white goods, electronic picture frames, phones, etc.)

In other cases, the technology is intended to be in the center of users attention only occasionally and on conscious will from the user: in those cases, we are talking about calm technology. The term calm technology has been formulated by the same Weiser in the already mentioned article and in the subsequent book “Designing Calm Technology” (Weiser and Seely Brown, 1996). Calm technology refers to those artifacts that don’t occupy users central attention the whole time (in use and not), but stay in the peripheral one until the users decide to focus on them. In other words, what calm technology proposes is to have non obtrusive artifacts staying in the peripheral area of attention when users are not engaged in the use, but that can still pass in the center of their attention in a smooth way.

As Löwgren points out, one important quality in the aesthetic of use of artifacts is the fluency. It is peculiarity of every artifact to be in the background and in the foreground of attention, but the quality is in the passage between these two stages, which should be as little disturbing and seamless as possible (Löwgren, 2009).

To be able to test and define the design space, it was necessary to confront the initial idea with reality. No good design can generate from only pen and paper: as Victor Papanek said almost 40 years ago, in a book that is still so contemporary for it tackles the same environmental problems that society is facing now, “The only important thing about design is how it relates to people” (Papanek, 1972). It is indeed fundamental as approach to observe the context from the outside, to analyze in a rational way, just as it is to go into the context and understand the reaction of users and environment on such ideas. That is why, from the early stage of this project, there has been a parallel “in-the-field” test of the concept. The field studies included observations on a well-defined category of users. More than the heterogeneity of testers, it has been privileged the analogy: 3 families living in independent houses, with 2 kids each, living in independent houses. It could be seen as an interesting group of people that has a normal status in the swedish context,
while having a rather high impact on the environment. In other words, those families, living in houses, owning one to two cars, are interesting case studies for behaviors and habits when it comes to green household attitudes. On the other hand, observing a collective house, where at the opposite edge, people have a proneness to prefer shared over individual, environment over comfort, gives a space for explorations and comparison.

6.4. Smart grids

The European Technology Platform for the Electricity Networks of the Future gives a definition of what smart grids are: “electricity networks that can intelligently integrate the behavior and actions of all users connected to it - generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies” (http://www.smartgrids.eu/?q=node/163). It is not necessary to study the smart grids system in depth for the understanding of the project, it is just enough to know a few important qualities that will benefit electricity networks. Smart grids make optimizations in the use and distribution of electricity, and allotment of energy depending on the request from the users. It improves the storage of energy, especially coming from renewable sources, and allocates the local produced energy in close areas that need it, cutting down waste due from energy traveling. A smart home connected to these grids becomes much more efficient, being able to communicate with the smart appliances present in it and co-ordinate so that the energy consumption becomes optimized. Smart grids can have metering enhancements called smart meters, which make the monitoring on what’s going on in the network for service providers, so that it is possible to be updated and able to adjust remotely energy loads (Beard, 2010). For users, consumption monitoring becomes easy and remote control becomes possible. This is a big benefit for sustainability living, being increased control a way to cut down consumption when superfluous in a very quick and accessible way. In the case of this project, smart grids facilitate the communication between humans and the white appliances in the household, but also the between appliances that are part of different households. This interaction will be thoroughly described in the following chapter.
In this chapter will be described in the details the project resulting from the interaction design master, fed on all the courses that helped shape a design thinking. The project is a blend of different design approaches, but also taking inspiration from existing products and/or services, users observations, design sessions, conversations with professionals. It can be categorized in the big field of sustainable design, it presents a mix of products and services (which makes it a PSS), takes advantage of calm technologies. Moreover, as PSS design project, the intention has been to keep a holistic approach throughout the whole path, considering the design of the new Stockholm area as drive to look at the life in those residential spaces as an interweaved set of qualities that users get in touch with, and that make the experience – the customer journey – as consistent as possible.

Starting from the actual project, which focuses on resource share in kitchen appliances, a mapping of a bigger design space has been made, having satellite projects/aspects that acknowledge three main points. The first sees the sharing of resources in other contexts than the ones taken into account, and involves for example laundries and central vacuum cleaners. These are not only design examples that feed in the peripheral projects, but also inspirational pieces that fueled the shaping of design thinking around the chosen design space.

Secondly, another class of peripheral projects implies the share of spaces and tools, [see section 5.3.1.2 Open Handyshop], including vacuum hoses and repairing tools.
Lastly, to have a consistent organization of the flat context, the intention is to see the appliances present as harmonic part of the whole, rather than separated pieces of a patchwork: this led to the idea of implementing skins to appliances, that have an aesthetical and interface consistency value to avoid the substitution of an entire appliance just for the visual look of it.

From the sketches, it is possible to grasp the overview mapping, which visualizes in an iconic way the condivision of a resource among more devices.

7.2. Kitchen

The kitchen is a place of high concentration of technological devices. From the fridge, oven, dishwasher and all the small automated devices – coffee maker, water kettle, food processor – it is hard to find something that is still working by hand. Yet, those devices need power to be able to work.

As observable in the graph below, already in chapter 2, a lot of the devices that contribute to the overall electricity consumption are to be found in the kitchen. For this reason, this context was subject of an extensive study for the project. The necessity seen was to reduce energy consumption of course, but as a ground that is now frontline of most kitchen devices company, the intention was to make something less panacea and more effective than the last eco-friendly dishwasher.

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<tr>
<th>HOUSEHOLD POWER USE (KWH)</th>
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<tbody>
<tr>
<td>LIGHTING</td>
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<td>FRIDGE/FREEZER</td>
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<tr>
<td>COOKING</td>
</tr>
<tr>
<td>TV, DVD, STEREO</td>
</tr>
<tr>
<td>COMPUTERS</td>
</tr>
<tr>
<td>WASHING MACHINE/DRYER</td>
</tr>
<tr>
<td>DISHWASHER</td>
</tr>
</tbody>
</table>

Electricity consumption in Sweden (http://www.sweden.se/eng/Home/Society/Sustainability/Facts/Energy)

The radicality of the initial idea was seen in the reduction of use of those devices by having them located in common areas in buildings, to encourage the mutual share of them. The users observations revealed that people are not prone to share household appliances, for it takes away the freedom of not planning ahead of time, unless they are by choice part of a collective living. The brainstorming with the Electrolux team helped finding a solution to this wicked problem: if people prefer the autonomy of owned appliances,
why not have them share the resources in earlier stages, giving them the same comfort as individual ones?

Several thoughts and ideas were generated from the discussion on sharing and households, the most relevant to the previous research and direction have been developed in this thesis; they will be explained further.

### 7.2.1. Share cores

The current topic of conversation is on core sharing, meaning to have a central appliance motor hub that feeds two or more appliances. Sharing a central hub (an engine that is collectively used) could happen in two different instances: it can either be shared by all the households, or just be semi-shared, meaning that only few household will access that resource. The benefits of the two methods are different according to the kind of resource shared and the appliances, thus the choice of having a hybrid mix of building shared device resources, and semi-shared ones. Obviously, the best result in sustainability is in having as less shared cores as possible, but the fact should not be a reason of discomfort for the users and a technically too complex and expensive solution to build.

### 7.2.2. Fridge

The fridge is, without any doubt, one of the most important appliances in households. It is not just an appliance, but a central place in every home. Why would that be? It is in the physical properties and in the central location it takes in the context (Swan and Taylor, 2005). The kitchen is a common area, and the device itself is widely used by every family component.

In this research, the intention has been to minimize its impact, being it something no one can renounce to. Still, considering the premises, ideas have been generated

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Concept for central fridge hub
around the “share-cores” concept: several technology and design aided thoughts on minimizing power need on the machine of cold.

As first option, the central hub has been considered as design to be implemented in newly built residential spaces, which would be positioned in a shared area in the building – most likely the basement – that can easily reach and give access to all the flats present. Pipes traveling in the walls will be able to transfer the cooling element, which usually only travels from the bottom-situated engine, to the whole fridge. Having a detached motor will allow more fridges to be connected and power supplied, with consequent save of electricity.

The second option is instead of having a semi-shared core, meaning that instead of the whole set of fridges in the buildings, it will be serving only few of them. In the specific, the core could be able to serve 4 fridges, located in wall corners. The benefit of a semi-shared solution, is the partial independence that can play a favorable role upon breakdown: whenever for a centralized core there is a technical complication, all the flats – and most importantly, the users – will suffer from it, with a semi-shared, semi-individual alternative, the problem is limited sensibly, to only a few (unlucky) subjects.

The matter of detached cores poses an attribute that might seem as a limitation at first consideration: unlike stand-alone fridges, they will not be possible to move away from the pipe that will transfer power. To contrast this, a list of alternate configurations might be given from the designers of the buildings, by having a multi-socket pipe system that allows user to position the fridge in several (given) possible locations.

To go in the detail of the fridge design, a research has been made on existing products, leading to the Eletrolux Design Lab competition winner in 2008, project that gained a lot
of attention for its smart yet simple nature. The project, called “Flatshare”, is born from a different need than the one discussed here, but still flexible enough to be adapted for the use in consumption-wise housing places. As the name tells, Flatshare is a fridge for people that share the same flat, that still want to keep separate things in the cold, just like many students experience all the time. It basically consists in several modular fridge boxes, which are still using the same engine. It could be seen as a small scale example of the share of core with individual outlets, thus a consistent piece in this study. (http://www.dexigner.com/news/16006; http://group.electrolux.com/en/austrian-design-student-wins-electrolux-design-lab-2008-with-his-concept-%E2%80%9Cflatshare%E2%80%9D-1990) Furthermore, the benefit of having a modular, stackable fridge in a household, is an added quality in the interaction with the artifact, that led to generation of further ideas with this concept. To benefit fully of the modularity attribute, the user can indeed decide to activate one extra module for that dinner with friends, or leave only one on with long lasting food when going away for holiday. Also interesting the possibility to choose the temperature for each module, that can be converted from fridges to freezers and viceversa, according to user's needs. Not only separating food belonging to different users, preserving smells and quality, but high personalization in dimension of the fridge. The difference in households with a single component, as opposed to a big family, needs to be considered in the design process, for there is a huge benefit in avoiding universal design: the worst-case scenario design takes more resources, both in the manufacture and during the life of the product, and it does not give comfort in use and interaction with humans, because most of them don't fit in the worst cases range (McDonough and Braungart, 2002).

7.2.3. Dishwasher

The dishwasher is probably the device that communicates best the statement made in this project: “Shared resources, calm appliances”; in other words, the appliance that best shows collaborative consumption to individual users with use of calm technology. By sharing a wiring connection, the dishwashers can transfer quickly the heated water necessary to clean dishes, benefiting both in terms of water and energy saving, by encouraging people to wash at the same time as neighbors do. Whenever an appliance in the
building will be activated, it will have a cycle of wash that will clean the dishes (in modern dishwashers, it is around 10-15 liters). In the last part of the washing, the dishes – now clean – will have a final cycle of wash with hot water. That same water could effortlessly be used to be in the first cycle – when the dishes are at their dirtiest – of somebody else’s wash.

But how to communicate that to the users, encouraging them to actually modify their plans to clean the dishes when more convenient to the community, and not only to their own need? The communication can happen on several layers: visual and acoustic. To mention again calm technology, it is important that the device does not travel from peripheral attention to central in a too abrupt way. Just like the power aware cord by the interactive institute (described in chapter 2. Framing the question), the dishwasher will use chromatic manifestations to communicate the user that this is the best time to wash, because somebody else has already started washing, and the process will be shorter and less impactful for the environment. This could also revert the assumption that a dishwasher should start working only when completely full of dirty dishes, and the reason is that it might be less consuming to run a dishwasher that is filled, for example, for 2/3 of its capacity, because the water and heating that is normally required to be used by every dishwasher does not need to be produced totally, but only partially, taking as much as possible from shared resources.

This message that is so important for the user to know, the time of collective consumption of resources, is communicated with a calm technology approach. One might think, if that is so important, why run the risk of skating by unnoticed? Donald Norman gives a good answer in his book “The design of future things”: humans and machines have a communication that is somehow walking on a very thin line. Machines rely on automation, which means that they cannot cope with unexpected or new events, or simply different paths than the ones the designers planned for them to react to (Norman, 2007). Just like Norman explains in his example, it is not always good to give feedback to users in a way that intrudes to their life: a beeping signal that tells that the dishwasher is ready can be useful during the day, but only bothering when the person is asleep. Still, it is not possible to simplify so much the range of possible moments. If the person is spending time resting for a flu, a beeping during daytime, when in a normal situation is ok, becomes all of a sudden inappropriate. It is not possible at the moment to communicate to the appliances in a mind-reader way,
that is why it is not necessary to improve automation, but to humanize machines. To quote Norman, "We need a calmer, more reliable, more humane approach. We need augmentation, not automation". (Norman, 2007)

How this translates as an effective method of calm communication in this project is an attempt to create a softer tone in the feedback from the device. The dishwasher will glow whenever it wants to advise the start of a wash, similarly to the power aware cord. Simple color glows, a signal that can stay in the background of attention and require a decodification to be understood from the user. If the appliance glows when ready, it is not necessarily enough for the user to receive the feedback: (s)he could be in another room of the flat, missing the silent message. On the other hand, the beeping has two major problems: first, it can be disturbing because too abrupt in certain moments, and secondly, with the invasion of technology in homes, the beep sound is something that is so common, to be difficult to allocate to one device instead of another. It is too generic, every device is capable of beeping. The alternative could be instead to have a light signal that is possible to receive in the living room of the apartment as well, which is discreet enough to be seen only when the user’s attention is above a certain threshold (for example, not when resting). A silent glow, a feedback that is not too disturbing and still leaves the choice to be ignored.

Other ways of communication of the dishwasher are through the display interface, which can give the choice to monitorize and personalize the settings, as well as giving some important information about the consumption during moments of collective resource use. It can either be analytical, giving information of the amount of water and electricity saved, or educational, giving data on how that previous wash, made in the right time, saved as much water as needed for a tree. Not only it educates users to new parameters of good behavior, but it also augments the feeling of being part of the community of people that is moving towards a better environment. Something similar to the concept of the Zipcar community [See section 5.3.2].
7.2.4. Oven

Usually in the buildings plan, it is a common practice to set all the plumbing and wiring in the most efficient way: for example, the water plumbing for the kitchen sink, serves at the same time for two flats. That means that the two flats will have a mirrored configuration.

For the oven, this is a good aspect that can be used to allow exchange of resources. This means that the two devices could be interconnected so to be able to share heating, or better, to transmit the heat from one oven to the other.

Let’s imagine an ordinary situation, when we are preparing a cake. We will need the oven for one hour, but in truth, to be able to have that, we will need to allow the oven to heat up first: it will take some minutes, depending on the temperature we want and the size of the oven itself. After the cake is ready, we will turn the oven off, but it will take it some time for it to cool down. Some ovens have a fan that helps the cooling, that will otherwise take much longer time.

It is almost dinner time, and the neighbors are starting their dinner. Same process of warming-up, use, cool down. What if the heat that just got dissipated in our oven, after long time, could be transferred to the neighbors; avoiding extra energy for us to run a cooling fan, and them to have the oven having to warm up? This way energy could be easily saved, without having the users worrying to actually engage in a complex activity to reduce consumption, but augmenting that existing behavior. To communicate the availability of instant heat, the glow system could be implemented in the oven appliance as well, with a different color coding: of course we are talking about two different kind of resources with a dishwasher and an oven – water and heat – that it is possible to attribute respectively blue and red to communicate to users in a simple way; the connection to the meaning of the color is effortless, at least for people from western countries.
7.2.5. Skins

This section presents content that is closely related to all the kitchen appliances just described. In some way, it is a transversal section which integrates in the design of these devices. It will describe the problems that have led to this choice, and possible configurations.

It is common in Sweden that the white appliances already present in a furnished apartment will be kept by the new tenants, unless special conditions invite to do the opposite. After time, and with several tenants moving in and out of the place, it is possible to see that the initial harmony among the appliances and the furniture, has left in favor to partial customizations and additions to the existing.

The place will start losing consistence in the appearance, as well as in the way the devices work during interactions with users. Having devices coming from different brands and produced in a wide time range, makes mental models they use highly variable, causing confusion or at least discomfort for the user in the interaction. For example, knowing that the fridge has knobs that allow different actions, the dishwasher with another knobs configuration, the stove with touch technology and thousand small devices that use other axioms, can result as a kitchen transformed in a zoo of electrical devices, each requiring a (too) different approach from the user to have a seamless flow of interaction. If instead the housing estate, along with the white goods company, keeps the home appliances
coherent with each other the users will have a more harmonic experience: consistency is positive.
The intention to keep consistency in the interaction cannot be the only aspect: it is also necessary to keep an aesthetical coherence. If on one hand, the appliances are managed by the housing company, on the other, is the household members to have the task of furnishing the place. Of course, different tenants and a long time lapse can mean changes in the furniture: upgrades, additions, substitutions and so on; in few years, the whole look and setting of a place can change sensibly. To be able to keep a consistency not only with other devices, but holistically speaking, with the rest of elements present, the idea is to have the possibility to change the “skin” of an appliance. That means the external layer, which is visible both when in use and not, can be swapped to match new user aesthetical settings. The range of possible choices could be among the basic material covers: standard, wood, metal; plus a choice of colors: black, white, etc.

So in the end, there is a transfer of ownership from the tenant to the housing estate: the latter will purchase and make sure the appliances have a long life, while the user will be able to choose among a range of products in the moment of purchasing (now up to the housing estate), the preferred aesthetic appearance, and of course, use them.
This can initially be seen as a quirk of style, but has deeper implications, that can for example avoid the purchase of a new device, when the previous is still perfectly working, but just looking obsolete. Just by changing the front-end of the product, its life can be prolonged, until the need of change is real and justified.

**7.3. Maintenance**

As it is already happening, Electrolux Professional Appliances is a division that takes care of providing an assistance service to the housing estates that use their appliances in communal spaces - laundry locales - by giving bureaucratic aid and education to the estate’s personnel (Mont, 2008).

Considering the already existing service provided, it turned out to be much more realistic to see the company not only as a product provider, but also as a service offerer. As shown in the picture, a mapping has been designed to work as framework that unfolds a flow of events that builds a scenario.

Starting from the beginning, the housing company will get hold of Electrolux and subscribe a contract which will offer several things: the appliances plus a set of services. As already happening in current residential buildings, Electrolux can help with the bureaucracy part by giving assistance, loans and warranties, in order to give an added value for the estate to want to choose them instead of a competitor. Their employees can attend a course of basic maintenance to be able to keep the appliances in good state and also cope with most common issues that do not require a highly professional knowledge. So Electrolux could dedicate a limited time in teaching the estate people the basic of mainte-
nance for fridges, ovens, washing machines: delegating part of the work will also benefit them for not having an excessive number of issues to deal with, that could be translated in time, transportation and personnel costs.

Having set Electrolux as actor that comes in the scene for special events, the rest of the PSS sees the interaction between the housing estate and the users living in the buildings. Supposing the appliances will be owned by the housing estate, will mean that there will be put the right care on keeping the machines in as good conditions as possible, translating in a longer lasting life of those. Maintenance can be scheduled in pre-set periods of time, being weekly, fortnightly, etc. according to different tasks that need to be done to keep machines good. For example, the cleaning of filters to washing machines and dryers, as well as cleaning of oven inner parts, can be made more frequently than monitor of plumbing, which can happen monthly or even longer, depending on seasons (weather temperature can have impact on them). The fact that the housing estate will own the appliances can also be a benefit for the users, just like it currently happens with washing and drying machines in shared laundry rooms, transferring the responsibilities to the estate. The control over the appliances will not be the same, intended that users will not have the chance to buy their own devices, but rather choose among a pre-defined range of them on the first furnishing and whenever there is need to substitute the current ones for malfunctioning.

By observing the flow of events, a regular maintenance from the housing personnel giving them less hassles from doing it, plus a choice of personalization (as said in the "skins" section) will keep the users happy, meaning having them taking better ordinary care of the appliances (cleaning), which in the case of collective consumption, will benefit the whole
community, having an efficient resource exchange system. By reflex, better ordinary maintenance means less work from the housing company and Electrolux, just like in a virtuous circle every element brings in advantage for the others.

In the flow, Electrolux and the estate are the PSS providers, where the earlier stays in the backstage and the latter works as the real service contact for the users, being the mediator between users and the products. There would be no direct contact between users and Electrolux, but will be bridged by the housing estate, to facilitate a more structure communication between the parts. This way, users will contact the housing company that owns the appliances, and they will judge whose competence the maintenance belongs to as task: if ordinary, its employees – previously educated by Electrolux – will be able to provide the service; on the contrary, for uncommon issues, Electrolux will be asked to give assistance.

7.4. It's online!

The website is another touchpoint in this customer journey, fundamental because interconnected with the other appliances and not stand alone feature. The user can interact with it to accomplish different tasks: in fact it allows the user to be passive or active towards it, meaning that it can used for a simple monitoring function, or be able to visualize, send information to the service provider and the devices at home.

In the next subsections will be explained the functions of the website, which fall into three categories: monitoring, status checking, booking.

7.4.1. Monitoring

First function that is in the website, is the monitoring feature, considered as passive because, unlike the other two features, does not allow the user to send data to the service provider. Taking advantage of the smart grid system [explained in section 6.4], it is possible to retrieve much more information than before, because of the multitude of sensors and communications that are implemented in the service; this can be turned as useful and
There surely is a big potential in unveiling data on consumption, when usually the only data available for the user is the bill at the end of the month. As written in an article included in the book “(Re)searching the digital bauhaus”, “Electricity meters still look as they always have, a little box in a corner near the ceiling in your hallway or in your basement, with figures slowly ticking, showing an incomprehensible interval.” And again: “The electricity bill […] is the only feedback we have between everyday behavior and consumption” (Hjelm, 2009). That means what we usually see of our consumption (let alone consumption monitor add-ons) is just the amount of what we have to pay. That’s it, nothing else. But instead of showing how much it has been consumed, why not reversing it to how much it has been saved by having had an attentive behavior? This way the user feels rewarded by having had a good behavior, by seeing a positive result, instead of feeling guilty and frustrated for getting a bad conduct mark for having showered 5 extra minutes the night before. A recent article on the work environment shows how positive feedback as opposite to negative, leads to more positive response from the person. Otherwise, there is a counter productivity, decrease of motivation and commitment (Belschak and Den Hartog, 2009). In this case, work is not much different from other contexts.

So, next time our user will log in to his/her profile, (s)he will find data of how much it has been saved by washing dishes at the “Glow” moment. There are several ways that could represent such data: one could be the monetary saving of course. Another way, more educational, is the exemplification of the data, represented in a more figurative form rather than a numbered form.

A good example to bring up in this matter, is the two websites that Electrolux has to
represent the savings in households. They represent in a very simple and iconic way the hypothetic savings in a home where it is used a dishwasher as opposed to hand washing dishes (http://www.electrolux.com/watersavings/), or where there are efficient appliances instead of old ones (http://www.electrolux.com/ecosavings/) [Attached in the appendix].

For example, data that can be retrieved from the Water savings website, is that if the household will use the dishwasher for a year instead of hand washing, there will be a saving of 6093 liters, equals to water for 25711 cups of coffee. As communication technique, it is much more impactful to refer to something that the user is familiar of and can easily visualize in his/her mind, just like a cup of coffee is.

Having a kind of consumption-saving communication is the aim of this design, where there is a quick and easy understanding of the information given, which is not reproaching the user, but awarding him/her for the good conduct.

7.4.2 Status checking

Another feature of the website is to show the efficiency rate of the appliances in the flat. Since those appliances share the same core with others located in the same building, a non-optimal functioning of one could end up influencing the overall consumption, besides having a worse impact on the environment. In the end, higher consumption, higher bills, less resource share. For this reason it is no longer a just personal benefit keeping the appliances in good conditions, but a responsibility towards society. By making a comparison between the appliance’s optimal condition to the current, the website can give information on the status of it. For example, an increased consumption of the fridge appliance could mean that there is formation of ice in the freezer section, which only requires a cleaning session to re-stabilize finances and consumption. Whether one of the appliances appears to have a non-ordinary issue, it is possible fill a form to book a time with a professional, still from the same web page. This way, the periodic maintenance time booking with the housing estate personnel can also be made from the internet.

Sketch of the status check webpage
This feature will make the user aware of selective consumption, possible inefficiencies of the appliances and contact for a check on those. All of it by using a simple web interface to accomplish the tasks. Also, it will make it easier for the maintenance from the housing estate, which only needs to have a look at the household properties online, or receive a notification of required check by the tenants.

### 7.4.3. Booking

The last function included in the website is the laundry booking system. It includes a simple calendar overview with available slots that can be booked. The website can be accessed through mobile as well, allowing a simple sms to book for older phones. The same service can be set to send a reminder (email or sms) one hour before the laundry time starts, as well as sending a notification whenever the clothes are ready for drying.

### 7.5. The customer journey

The customer journey is an important tool for service design [see section 6.1], that maps out in a chronological order, all the touchpoints where the user meets the service or PSS in this case. Following is the customer journey of this project, similar to a scenario where a persona interacts with the design over time. The template used, modified to fit the project’s properties, is present in Stickdorn, M. & Schneider’s book (2011), and can be downloaded at http://files.thisisservicedesignthinking.com/tisdt_cujoca.pdf. [The full size, full color version can be found in the Appendix]
7.6. Side projects

This part, as well as it is not the core of the project, has been included in the PSS because closely related to the main topic. Also, being the project's nature a system embedded in rented residential buildings, the design should not just stop on a too narrow focus, but try and consider the context holistically. Unfortunately, time constraints have restricted the possibility to consider more in depth these side projects, which have anyway a big potential of improvement and implementation.

7.6.1. Laundry

In Oksana Mont's dissertation, a researcher graduated in Lund with a study on PSS and collaborative consumption, an extensive study has been conducted on the benefits of shared use in the context of Sweden (Mont, 2008), showing a fair background picture: the development of communal washing spaces started between 30s and 40s, initially with the intention of unloading women from household activities to be able to enter the job society (Mont, 2004). It was also extremely demanding in economic terms to own a washing machine, it was in fact only 1% of the population that could afford ownership over one of those in 1948 (Kjellman, 1989). That is also the reason why communal washing spaces gained ground quickly: in about 20 years it was 80% of swedish population with access to communal laundries (Hagberg, 1986). However, the frequency of use of washing facilities increased exponentially, without having full loads of cycles though (Henriksson, 1999), due to higher cleanliness and dressing conventions imposed by society (Mont, 2004). In swedish residential contexts, shared laundries are supposed to serve 15 flats. But, because of the choice of many to get their own appliances, these communal spaces have a density of 1 laundry per 25/30 households (Rosén, 1993).

As of now, the laundry areas in buildings in Sweden are mostly using Electrolux appliances, but it doesn't just stop with the purchase of those from the housing estates: the Electrolux Professional Appliances division provides installation, training of the estate personnel, maintenance contracts; also promotes the contract with the possibility of loans and takes care of aiding on the bureaucracy part, offering assistance with environmental permits (Mont, 2008).

This overview shows that collaborative use and consumption is already a developed aspect of housing in Sweden; very important to reflect upon the weak points in the system and try at the same time to generate discussions and challenge the behaviors. As Oksana Mont points out (2000), it is easier to share facilities when it becomes more convenient for the user in terms of finances, low frequency of use, space constraints, maintenance costs. Considering that housing estates implement laundry rooms for every 25/30 apartments, when the expected number of users is reduced to around 15, it gives the picture
of how this facility is somehow not seen as a comfortable experience as owning one. In the beginning of 2000, research studio SIFO published data on users' satisfaction on laundries: it emerged that 70% of the households are satisfied with the distance to the facility from the flat, 50% with the rate of availability of washing time, 76% is pleased with the equipment present, 40% with the cleanliness of the laundry space (SIFO, 2000).

By analyzing this data just presented, it is clear that users don’t really enjoy some aspects of communal laundries, which in fact makes housing estates implement laundry rooms at about half of the rate of density per household, because it is known that about half of them already have a own laundry in the apartment (Rosén, 1993).

Still, an individual laundry – washing machine and tumble or drying rack – is highly consuming and also take considerable space in an apartment. In a situation like this, where collective is uncomfortable and individual is unsustainable, truth is somewhere in between. The idea proposed here is indeed a semi-shared laundry, where, assuming the current regulations have the facilities providing for 15 flats, these are instead shared by a ranging number of 8/10 flats, located every second or third floor (depending on the flat number per floor). This can obviously benefit the ease of finding a time slot, which is at the moment displeasing half of the users. At the same time, having the laundry inside the building, only 1 or 2 floors away, is another factor of increased comfort for the user.

Another important issue observed in the field studies participants habits, is to have little to no awareness of the detergent to clean the clothes. Of the participants observed, no one dosed the soap, and also knew really where the pre-wash soap, wash soap and softener are supposed to be. As one participant said: "I know I could spare more than half of the soap if I dosed it, but I just don’t do it"; and another: "I never know where the soap is supposed to go, so I put it everywhere".

To avoid this, it is possible to have washing machines that can be filled with a considerable amount of soap, from which they will only take the needed amount at every wash: really efficient to avoid over dosing. At the same time, the washing machine is able to detect the quantity of clothes and the hardness of water, because both of them are important variables that change the amount of soap.

Moreover, as already in section 7.4.3, the booking system can easily be done through internet.

7.6.2. Central vacuum cleaner

The vacuum cleaner is a device created in 1860, but it was not until the beginning of 1900 there was the big leap in its design, as those years have seen the introduction of the centralized vacuum (thanks to the invention of David Kenney), a system of pipes that allowed the vacuum to be away from the spot but connectible to the flat. That way, a single vacuum was moved by a team of cleaners from house to house, using the built-
in structure. (http://www.ideafinder.com/history/inventions/vaccleaner.htm#The%20Story).

With the enormous success of the movable vacuum cleaner, the central system has not been so famous, despite its high qualities. Basically, the central vacuum cleaner allows people to install the engine usually outside the flat (in the basement for example), but still have the function available indoors, thanks to a piping system that makes it possible for the hose to be simply plugged to the ad-hoc wall socket, which can be put in several spots of the place. The advantages are several, and very important. First of all, the dust and allergenes that are in the air will travel out of the flat to reach the vacuum canister; in contrast, with a common movable vacuum cleaner, those particles will remain in the air, making the environment cleaner and healthier. In addition, because of the distant location of the engine, there is a reduced noise. Usually these central vacuums have a bigger engine and fan, so that makes them more efficient and requiring less maintenance (http://www.electrolux-centralvac.com). The central vacuum cleaner is common in countries in eastern europe, for its reduced costs. It has been an inspiration for the fridge concept [Section 7.2.2.]

7.6.3. Shared tools room

As already observed in the open handyshop and share some sugar examples, there is a genuine trend towards the share of hardware and tools. Especially in dense populated areas, it is harder to establish relations with people living in the neighborhood, the sense of community gets lost in the thread of everyday tasks, and the mutual help is harder to reach. That is the sparkling idea that launched the share some sugar internet community. By providing a shared area that is equipped with some household tools that are however not used on a daily basis, keeps users from buying unnecessary objects. The same vacuum cleaner hoses can be found there for example. Also, basic tools, ladders, and whatever is deemed as necessary, can be located in the shared tools room and be available for all the inhabitants of the building. These rooms could be in laundry spaces, being in a close distance for all the flats.
In a realm where the environment is gaining more and more attention for its condition of decline, new challenges are faced, leading to a necessary revision of the paradigm of western production. Economy and society need a radical approach (Morelli, 2005). This means that the enormous production and consequent waste have ended up harming the planet, thus not possible to keep as a future behavior. The whole idea of owning is brought into question, because the individual ownership is a big part of the production chain. In this panorama, it has been recalled as necessary to struggle to raise awareness and better behavior towards sustainability.

As already mentioned in the field studies, it resulted that people don't put enough care in having a good sustainable behavior in household activities. My personal intention is to research and generate ideas around the concept of avoiding waste by sharing resources. But do people really want to share?

Unfortunately, some lacks make it difficult for some people to be able to share in a relaxed way things with others. One lack could be the lack of time: tight rhythms increase stress, which can make relations harder to handle. Or simply, an extremely busy person will have harder time planning something as easy as the laundry. Booking system, possible queues, uncomfortable times; all of these can make the sharing not as quick and easy as owning. Another lack, is the lack of trust: after all, who knows how dirty the neighbor’s clothes were, and if this left traces in the water used in the following wash, ours?

What then, if instead of sharing the “front-panel”, the user touchpoint, there would be a more subtle sharing, a sharing of resources, while still keeping the ease of use of something that is always available?

There are several advantages in building houses from zero, and they can be summarized in one word: choice. Choice of materials, shape, design, location even. No dealing with adapting the old to new demands and needs, no restructuration, no patches.

What a unique opportunity to design a place that is not born old, like most of new buildings today. With born old, it is intended the use of obsolete technology, materials, architecture, design, that is not the best match with today's environment situation and society evolution. This opportunity, among others, is called Royal Seaport: a residential complex of about
11,000 flats, to be born in an old industrial area in Stockholm. Great attention is on the smart grids, as well as methods to reduce energy and heating waste, aiming to zero in the emission scale (Http://www.metacafe.com/watch/5445717/fortum_plays_key_role_in_stockholm_royal_seaport_project). In this project, which has already started but will be finished in 2025, are taking part several companies, among whom Electrolux, and also the Interactive Institute (http://www.tii.se/projects/royalseaport).

As the Electrolux professionals and I were brainstorming with the defined design space in mind, one of the team members mentioned the Royal Seaport project, seen as a possible connection to development of ideas generated.

In this perspective, a simple idea of a smart device or a more conscious behavior, left the scene in favor of a service oriented approach, where the shared and sustainable are seen as a holistical character in the living spaces, leading to a thought-through analysis of all the touch points. Speaking in terms of interaction design, this opens up to a world of possibilities previously only thought as belonging to the domain of architecture. The sole fact that appliances such as fridges and stoves could be built in, becoming integrated in a harmonic way in home settings, needs a whole new formulation of how the user relates to them, how they are seen and perceived, how they relate to the whole, and if they become a too burdening presence, or on the opposite, too bland. Plus, the user should not feel like his/her possibility of choice for a desired appliance has been taken away; the feeling should be focused on the use and accomplishment of task rather than the status in the society bound to objects. More than that, users should feel like, among all, the PSS in their home is the best solution, because of increased interaction quality, features, and sustainability.

In this panorama, very interesting is indeed to design the shared-sustainable as a whole: all the touchpoints, the backstage and frontstage of it; how the implementation can be made in the least harmful way possible (talking about materials and processes), how it can merge with the context, and how its identity is perceived by the final user. Just to give a concrete example, the formulation should be on how the fridge hub would physically be installed and plumbed in the flats, while still making it easy to monitorize and fix in case of breakdown; how the organization would be so that it is the most efficient and less consuming; how the new fridges will look in the apartments and which features they will have; how the users will interact with them and perceive when not interacting with them.

In the described domain, where users are encouraged to consume and share resources with the neighbors, fundamental is the way this is communicated to them. It should not be an invasive reminder to fulfill a task, or to say that this month they haven’t been so good with sustainable behavior, but instead be a subtle communication that does not break in the context, rather stays in the background until conscious direction of attention to its communicated message. Using the home context implies a delicate approach to the matter: users are everyday bombed by all kind of communications, being them advertising, devices feedbacks – from the phone to the car, from the coffee machine to the computer – so it is not needed to add more workload to people’s attentive reflexes. It is instead auspicious that the context is designed so it leaves the user in charge of the communication.
8.1. Are designers part of the problem?

The visual quirk as title of the section presents on purpose a double title, that will be explained thoroughly in this part of the chapter.

In a mere consideration, we could say that yes, designers are part of the problem. In the "Ecological design" book (Ryn and Cowan, 1996: 9), there is a strong statement concerning this topic: "In many ways, the environmental crisis is a design crisis. It is a consequence of how things are made, buildings are constructed, and landscapes are used. [...] Our present form of architecture, engineering and industry are derived from design epistemologies incompatible with nature's own". This is especially true if we consider the planned obsolescence practique mentioned earlier in this thesis report (Leonard and Conrad, 2010): designing with the objective of having those objects dumped before really needed and for no special reason, not having a cognition of the long term consequences on over use of resources and over production of waste (which is by the way pollutive). Of course, designers were not the starting point of this economic paradigm, but an important link in the chain, the one that connects the mere idea world to the actual up-and-running-artifact world.

But, with the current situation of environmental crisis, it is again the designer's role to have an important part in the change, by using better and less pollutive materials, by planning for long term life rather than quick obsolescence, by encouraging in the shift from owning to using. And regarding this shift, it is essential to consider services and PSS as an alternative to helpless waste, as a urge to behavioral change and ecological aware lifestyle. Talking about behavior and lifestyle, it is important to consider not the single object or artifact, but the holistic system, the context and the interactions. In my opinion as interaction design student and according to the research conducted, residential buildings are contexts in which there is a big potential for sustainable living improvement, for the high negative impact it has in the environment because of consumption and waste. Just because nothing exists out of the context, it is important to consider the composing elements in the whole, how they interact with each other (even humans) and their impact in the totality.

This is why in this paper, interaction design served as an important point of view for the implementation of sustainable PSS in residential buildings. It has recently been part of a discussion whether design should be included in the PSS discourse (Morelli, 2002b), initially only focus of marketing disciplines. The contribution of design, as Manzini notes, is fundamental to enrich the vision with insights on users' behavior and response to technologies and product-services (Manzini, 1993).

The fact that in a PSS several classes of subjects (provider, technology, service, user) take part in the act, a careful planning of all the events is vital to the quality of it: this is the role of the designer in the PSS. An interaction designer, being a professional that doesn't have the constraint of planning and designing a product or a whatsoever tangible artifact, but has the ability to conceptualize virtual and tangible and envision the meaning generated by the embodied design (Dourish, 2004), is the figure that fits in the picture
when it comes to shape the PSS. Since the study of PSS in design is a new practice, it is needed for the designers to broaden the domain of knowledge and expertise towards the social sphere, where is the society as a whole to be considered, as long as economic evolutions (Morelli, 2002b). This way, the consolidated competencies of the interaction designer, such as research, user experience, technology, interfaces, etc. will lead the process development in conjunction with the construction and awareness of new economic models – based on services more than ever before – and its effects on social behaviors, perceptions and expectations.

8.2. Future work

This section contains all the sides and aspects of the project that haven't been investigated for time constraints. The part that is decisive in making the project valuable for actuation is obviously the in-the-field testing. In general, testing the users when living in the housing building, interacting with the appliances, the neighbors, and the service: basically, see how people take part in the PSS, analyze the response with all the touchpoints, react to a context immersed in calm technology. As a consequence, see how people take a more sustainable approach; not only for the occasions when they are actually interacting with the project, but observe if, by having a pleasurable experience in the home environment when using the designed facilitations, their awareness in a holistic view is somehow striving for responsible behavior towards sustainability. This is of course quite hard to say at this stage of development, for two main reasons: first of all, the time needed for observation would be considerable – months, even years – secondly, the context where the PSS is taking place will also have influence on it. For example, living in a context where sustainability is a central topic that people is open for, will serve as better ground for the implementation of the project. A testing of further prototyping is also necessary to refine the aspects that make the PSS, knowing that there is potential for further development.
This thesis project has been an exploration on the possibilities of improved sustainability in rented residential buildings by using calm technology to encourage the sharing of resources. It investigated the potential of using a product service system (PSS) to create a coherent experience in the interaction between users and the home appliances. The PSS resulting is the combination of smart appliances based in the kitchen, which share resources (electricity, water and generated heat) with other households in the same residential building. These appliances are able to detect whenever a neighbor is using the home appliance, being it dishwasher or oven, and send a feedback to our household encouraging the use of the same appliance in case of need, because it will be able to take resources from the neighbor’s one. This way, resources that would otherwise go wasted (just like the heat generated when using the oven), are transmitted in another appliance, thus saving consumption (the neighbor’s oven will take in the heat from ours).

The way chosen to convey feedbacks on advised moments of appliances activation, due to shared resources use, is the one not being disruptive, by using calm technology to communicate in a discreet and smooth way to the user.

Besides the product part, the project has an integrating service part, of monitoring and maintenance, that is manageable through its website. It is both a platform for the service provider and the user, where the latter keeps track of consumption and environmental benefits through the share of resources history. It is also possible to monitorize the efficiency status of the kitchen appliances, so to be able to contact the service provider for maintenance. The same service provider can observe the network structure and its functioning, as well as the single appliances in each of the households. They can as well receive requests for maintenance bookings from users.

This thesis strives to communicate the importance of the role of designers in the residential buildings, and how they can be planned so that the focus of the inhabitants is on the sustainable use rather that the unsustainable ownership. Because this can only be achieved by reaching a shift in the behavior, it is fundamental that all the PSS touchpoints are carefully planned, to make the experience most valuable for the user.
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Lstrip - Project overview
**The kitchen**

**Board diary**

From ________________ to ________________

First and last day of use of the board diary

<table>
<thead>
<tr>
<th>Day</th>
<th>People at dinner</th>
<th>Nr of dishes</th>
<th>Difficulty of dishes</th>
<th>Overall estimated cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 2</td>
<td></td>
<td></td>
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<tr>
<td>Day 3</td>
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<tr>
<td>Day 4</td>
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<tr>
<td>Day 5</td>
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</tbody>
</table>
### Probes

#### The kitchen

**Board diary**

#### Trips to food-store

<table>
<thead>
<tr>
<th>Mode</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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</thead>
<tbody>
<tr>
<td>Car</td>
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<td>Bus</td>
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<tr>
<td>Bike</td>
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<tr>
<td>Walking</td>
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</tbody>
</table>

**How you have reached the food store**

#### Food spared for

<table>
<thead>
<tr>
<th>Category</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work/School</td>
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<td>Day after</td>
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<td></td>
</tr>
</tbody>
</table>
The kitchen
The setting and the interactions

Draw your kitchen setting and the path covered when preparing food
Day: ____________  Names: ___________________________________

Draw a simple sketch of the kitchen and the dining area, then approximately draw the path covered when prepared food.

Things I enjoyed

Things I disliked

If something unexpected happened, or an ordinary situation gave problems or made the food preparation process enjoyable
The laundry
Board diary

Day: __________ Names: _____________________________

Baskets per session

White:  full    empty

Colored:  full    empty

How many baskets per session and how full the washing machine was

Have you dosed the soap? [ ] yes [ ] no

Did you use the same program for all washes? [ ] yes [ ] no

How many trips to the laundry until it was finished? ___
The laundry
The setting and the interactions

Draw your laundry setting and the path covered when washing and drying clothes

Day: ____________  Names: ________________________________  

Draw a simple sketch of the laundry and drying area, then approximately draw the path covered when doing the laundry.

Things I enjoyed

Things I disliked

If something unexpected happened, or an ordinary situation gave problems or made the food preparation process enjoyable
Your household will save:

How much you can save

**Carbon dioxide**
The amount of carbon dioxide emissions saved is equivalent as if driving a car 2,641 kilometres.

**Money**
The money saved in the average household is equivalent to a stack of Euro coins 18 cm high.

**Electricity**
The amount of electricity saved is equivalent to one 60W light bulb shining day and night for 348 days.

**Water**
The amount of water saved is equivalent to 7 hours of flow from one tap in the household.

<table>
<thead>
<tr>
<th>441 kg CO₂</th>
<th>741 SEK</th>
<th>501 kWh</th>
<th>3,088 Litres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td>Money</td>
<td>Electricity</td>
<td>Water</td>
</tr>
</tbody>
</table>

Average household  Malmö  Sweden  Europe

Change country and city

Electrolux eco savings
Your household would save 6,093 liters of water per year by switching to a dishwasher instead of washing by hand...

...that's enough water to make 25,711 cups of coffee.
Carl moves in! He is having a welcome party/dinner with friends, so...

Carl activates the needed fridge modules + 1 freezer module for beer.

The neighbors make dinner. The oven glows!

Carl prepares his dinner in the oven, which is instantly warm.

Carl + friends have dinner. Dishes fill up the dishwasher.

Carl turns on his dishwasher, knowing it will take hot and clean water from the neighbors’ dishwasher.

While people is enjoying the afterdinner, the dishwasher starts glowing.

The following day, Carl checks the housing website. He saved 7 liters of water, equals to 35 cups of tea...

He checks the status of his appliances, which are 100% efficient.

The maintenance check with an housing estate professional is scheduled in 2 months.

Carl can as well book a laundry time on the website.

He checks the status of his appliances, which are 100% efficient.

The maintenance check with an housing estate professional is scheduled in 2 months.

 Carl turns on his dishwasher, knowing it will take hot and clean water from the neighbors’ dishwasher...

While people is enjoying the afterdinner, the dishwasher starts glowing.

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customer journey canvas