

Challenging the Car Norm: Opportunities for ICT to Support Sustainable Transportation Practices

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ABSTRACT

The use of practices as a unit of analysis has been suggested in order to scale up efforts within sustainable HCI and to shift the focus from changing individual behaviours to supporting transitions at a societal level. In this paper, we take a practice approach to the case of sustainable transportation, and more specifically to car-free transportation. Car use is intertwined in many practices and managing life without a car is difficult, particularly for people in contexts where owning at least one car per family is the norm. We studied three families in Stockholm who replaced their cars with different combinations of light electric vehicles during one year. From the families' experiences, we identified a number of opportunities for designers of interactive technologies to support environmental pioneers in the particular case of car-free living, as well as to support transitions towards sustainable practices in general.

Author Keywords

Sustainable HCI; practice theory; practice-oriented design; transportation.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

In the past years sustainable HCI has dealt with numerous interactive technologies aiming to support, inspire or persuade people to adopt pro-environmental behaviours. A central feature in this approach has been eco-feedback: information to users about the impact of their behaviours on the environment. However, sustainable HCI has been criticised for “*turning the problems of environmentalism into questions of personal moral choice*” [8:8], focusing too much on individual consumers [7] and using persuasive technology with a narrow focus on individual behaviours [5]. The same authors see opportunities in

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Figure 1. Examples of the light electric vehicles used in the study: a scooter (top left), a four-wheeled motorcycle (top right), a box bike (bottom left) and a bike (bottom right).

supporting environmental movements [8], addressing collective, regional and national levels [7] and shifting the focus from behaviours to practices [5].

The use of practices as a broader unit of analysis is increasing within HCI in general, although the practice approach is often not explicitly stated [17]. In this paper, we explore how a practice approach can be used to inform sustainable HCI for the specific case of support for sustainable transportation practices, with a focus on car-free transportation.

Cities have for many years been designed with the car as the principal and ideal mode of transportation. However, with local issues of congestion and pollution, and global challenges such as climate change and peak oil, a change is needed in how cars are used. In Sweden, about 60% of all commute trips are made by car [27] (which can be compared to the US where the car is used for almost 90% of the commute trips [9]). Car use is lower in metropolitan municipalities in Sweden (Stockholm, Göteborg and Malmö), with about one third of the commute trips made

by car and another third by public transport. Stockholm, with nearly 1 million inhabitants in the city and about 2 million living in the region, has a well functioning public transport infrastructure with buses, commuter trains, trams, boats and a subway system stretching from the city and out to the suburbs and neighbouring cities. Several initiatives have been carried out to reduce car traffic in the region, such as introduction of congestion charges for cars and investments in extended public transport infrastructure.

However, owning a car is in Stockholm still a norm in many contexts, particularly for families with children, and it may indeed be challenging to manage life without a car, despite good public transportation and existing cycling infrastructure. In the project *A Car-free Year*, we have studied the changes in the practices of three families with children, living in Stockholm, when they replaced their car with light electric vehicles for one year. The project supported the families throughout this change by storing their car for the year and providing rental agreements for the light electric vehicles: scooters, four-wheeled motorcycles, box bikes and bikes (see Figure 1 for examples of the vehicles). By following the families during the year we have learned about challenges, as well as positive aspects, of living car-free. We analysed this radical, and very local, change with the aim of identifying ways that design and ICT can support change, also on a societal level.

In this paper we first present a case study of the families' car-free year, including their motivations, challenges and changes in practices. Secondly, we use a practice theory lens to analyse the positive and negative experiences associated with the families' new practices. Finally, we present a number of opportunities for ICT and services to build on these positive experiences or overcome negative experiences in order to support the specific case of sustainable transportation practices, as well as transitions towards other sustainable practices.

RELATED WORK AND THEORETICAL FRAMEWORK

The widespread use of cars has changed how cities are built and citizens have, to a great extent, become dependent on cars to move around between home, work and various leisure activities: "*[the car] forces people to juggle fragments of time so as to deal with the temporal and spatial constraints that it itself generates*" [28:4]. Habits play a central role in the choice of transportation mode and information about alternatives may not be enough for people to change their habits [29]. To break the car habit and decrease the use of cars in city centres, congestion charges have been introduced, and successfully reduced traffic, for example in Stockholm [2] and London [23]. While the overall effect of the congestion charges was positive, such a change negatively affected some citizens and to a great extent influenced their practices [23].

There are many factors influencing our transportation choices and numerous studies of how this process can be supported by ICT, particularly in the form of travel planning information, to encourage more sustainable travelling. It has been suggested that travel planning tools should provide information not only about time and cost of different alternatives, but also about convenience, comfort and privacy [6]. Personal recommendations that nudge people to choose transportation modes or routes with lower carbon emissions have also been proposed [3]. A review of existing travel planning tools found opportunities for improvement by providing: information about non-travel options (e.g. virtual meetings and e-shopping), information about ridesharing options and easy access to online payment and tickets [13]. Eco-feedback has also been explored as a means for influencing travel behaviours, for example in a study of the system UbiGreen [10] where some of the "least green" users thought that the feedback helped them to make more eco-friendly transportation choices. Additional factors the users believed would encourage them to make more green trips were: reliable transportation, financial incentives and more knowledge about alternatives. UbiGo [24] is another travel information system that, during a six-month field study, provided a travel service for multimodal travelling together with rewards for green trips. The UbiGo study found that perceived benefits in terms of convenience and cost were more important for long-term engagement than the rewards for green trips.

While travel information and services tend to focus on individual choices, there are also factors beyond the individual that are important to take into account. Specifically for sustainable transportation, it has been suggested that HCI should, in addition to personal aspects, also consider social values (e.g. environmental concern), societal factors (e.g. financial situations) and structural factors (e.g. infrastructure) [20]. Proposed approaches are designing for: entertainment, education, community support and political activism. Social norms, for example related to being on time and being a good parent, have also been identified as important influences on travel practices [19].

In order to increase the understanding of the complexity of what influences how we do things and to create support for more sustainable practices, practice theory and practice-oriented design have been proposed as ways forward [16, 18, 21, 25]. Such approaches have been investigated for energy related practices such as doing laundry [12], bathing [14] and thermal comfort [15].

Practices are constituted by elements that can be divided into *material*, *meaning* and *competence* [22]. *Material* refers to the technologies and objects involved in a practice, *meaning* refers to shared symbolic meanings and ideas of a practice, and *competence* refers to knowledge and skills used in a practice. Shove et al. suggest that

	Housing & area	Family members	Electric vehicles (monthly fee)	Previous car use	Distance to main activities
<i>Family 1</i>	Detached house in suburb	Mother, father, three children (aged 8-15)	1 four-wheeled motorcycle (€240) 1 scooter (€80) 1 bike (€50)	Daily for work (mother). Regularly for family activities, occasionally for renovations.	Work: 4/20 km Sports activities: 2-12 km Visit family: 6/50 km
<i>Family 2</i>	Apartment in suburb	Mother, three children (aged 11-13)	1 two-wheeled box bike (€70) 1 bike (owned by the family)	Regularly for evening and weekend activities. Visit summer house during holidays.	Work: 7 km Sports activities: 2-50 km Visit family: 470 km Summer house: 480 km
<i>Family 3</i>	Apartment in centre	Mother, father, three children (aged 2-9)	1 three-wheeled box bike (€70) 1 two-wheeled box bike (€70)	Occasionally for evening and weekend activities. Visit summer house during weekends and holidays.	Work: 7/3 km Sports activities: 1-11 km Visit family: 1/170 km Summer house: 70 km

Table 1. The families who participated in the car-free year.

“opportunities for effective intervention may lie in the generation and circulation of elements of which variously sustainable practices are made” [23:472]. This approach has been built upon and adapted for HCI by Mose Entwistle et al. [18], who presented the *Contextual Wheel of Practice* as a framework for understanding practices within HCI research. We will detail how we applied practice theory to our analysis in the next section.

METHODS

In the car-free year study we have combined participatory action research with a practice-oriented design approach. With this intervention “in the wild”, we as investigators have participated in the study at the same time as the participants have been investigators; “as analysts of their own and others’ practices” [4]. Our participants have been encouraged to reflect throughout the study, while the project team helped the families by providing car-free expert advice. This intervention has been the first phase of a practice-oriented design process, aiming to increase the understanding of car-free transportation practices in order to inform design for sustainable transportation.

To recruit families for the car-free year, we advertised a call for participants on the project’s Facebook page and in Facebook flows targeting people with an interest in sustainability. The call included three requirements to qualify for the study: the family had to live within the urban region of Stockholm, there had to be at least one child living with the family and they had to currently own a car. The reason for selecting families with cars, rather than families who were already car-free, is that we were

interested in understanding the changes required to adapt to car-free living. This approach is different from studying people who already have a certain lifestyle, such as the “simple living families” in [11].

We received 74 applications and, after interviews with 11 families, 3 families were selected for the car-free year. To ensure richness in the collected data we selected families to cover both households in apartments and in detached houses, single parents and two-parent families, families living in the city centre and in the suburbs, and families with young children and with teenagers. There was also a mix of ways in which the car was previously used (see Table 1). The differences between the families were reflected in the challenges they met, and particularly the type of housing and the age of the children came with different challenges. Also the location of work, sports activities, friends, family and summer houses affected the families’ car-free experiences.

There were also similarities between the families: all of the adults had university degrees, lived in middle-income areas and were well aware of sustainability issues. They were active families, with particularly the children attending, and needing transportation to, different sports activities (e.g. handball, football, athletics and martial arts). Other activities where the car was used included shopping, visiting friends and family, travelling to the summer house, and going on ski trips and other holiday trips. All three families lived a few minutes walk from the nearest subway station and they already before the study used public transport for some of their activities.

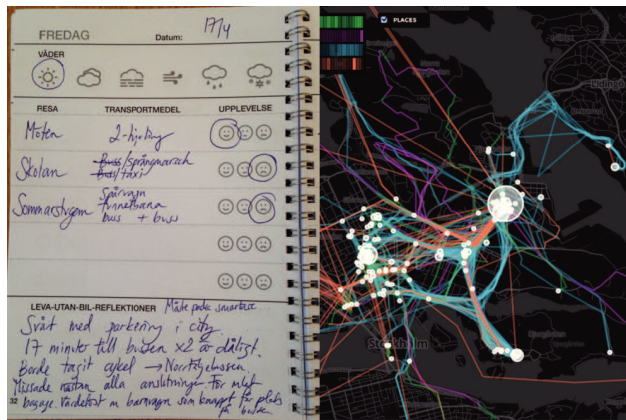


Figure 2. Trigger material used in the interviews: a trip diary (left) and a visualisation of trips colour coded by transportation mode (right).

The families' car-free year started in October 2014. The project provided, for a monthly fee paid by the participants, the families with the light electric vehicles of their choice (see Table 1). Included in the fee were maintenance of the vehicles and expert advice on appropriate equipment and other practical aspects of using the vehicles. During the year the families did not have access to their own car but they were allowed, if needed, a maximum of 24 car trips by taxi or using a borrowed or rented car (at their own cost). We conducted monthly interviews with the parents from September 2014 until May 2015, and final interviews in September 2015. The interviews mainly took place in the families' homes. One of the interviews had specific questions for the children, who joined their parents for a part of the interview. Each interview lasted for 1-1.5 hours, with one main interviewer in charge of the interview and one note-taker making detailed notes. Audio from the interviews was recorded to support the notes. Prior to the interviews the parents had a "log week" when they noted down all their trips, their experiences of the trips and other reflections on car-free living (see Figure 2). In addition, during all weeks the parents used the smartphone app *Moves*¹ that automatically tracked their trips. This data was visualised on a map with the connected app *Move-o-scope*² (see Figure 2). The trip visualisations and the notes from the log week were used as probes in the interviews. Other such probes were: a 24-car-trips card where the families registered any car trips they made, photos they posted on the project's public Facebook page and other photos they had taken related to their car-free life. The interviews were complemented with observations of practical arrangements for the vehicles and their charging, of associated equipment and of other physical manifestations of the new practices.

¹ <http://www.moves-app.com>

² <http://move-o-scope.halftone.co/>

The application forms, notes and photos from interviews and meetings, log material and posts by the families and other visitors on the project's Facebook page have been analysed with a practice theory lens. The first step in the analysis was to gain a broad understanding of the elements of the families' new practices and whether they contributed to positive or negative experiences. We used the four categories proposed in the *Contextual Wheel of Practice* (COWOP) [18] to structure the different types of elements. The COWOP categories correspond to Shove et al.'s [22] division of elements, but the names differ: *meaning* becomes *societal structure* in COWOP, *competence* becomes *the individual*, and *material* is split into *near materiality* and *infrastructure*. This distinction between *near materiality* and *infrastructure* is the main inspiration we have taken from COWOP. In transportation, infrastructure is a dominant topic for example in political proposals and discussions in media. This was also reflected in discussions with the families and within the project team, but the distinction helped to not forget elements of near materiality. Although COWOP describes *near materiality* and *infrastructure* as categories of "physical" elements (the technologies, objects and infrastructures involved in a practice), we decided to include also services in these categories, since we found services to be an important part of life without a car.

As a second step in the analysis, we focused on the role ICT and connected services played in the new emerging practices and on the potential roles for ICT in supporting sustainable transportation practices.

ELEMENTS OF A CAR-FREE LIFE

This section introduces stories and examples that illustrate the most central elements of the families' car-free lives, divided into: motivations for abandoning the car, new practices, planning, the norm of the car, practical challenges, emotional challenges and benefits of not owning a car. As the car-free year project has been presented nationwide in various media, we are protecting the privacy of the families by not revealing which family each story comes from. However, we have provided relevant contextual information about the respective family whenever needed.

Motivations for abandoning the car

The applicants to the car-free year had many different reasons for wanting to get rid of the car, and the motivations were both practical and emotional. Practical motivations included saving money, doing more physical exercise and not having to worry about maintenance of the car, while emotional reasons were mainly related to concern about the environment and the coming generations future lives in cities.

Environmental concern was by far the most common motivation given and applicants often listed other things they did for the environment: buying organic food,

reducing their meat consumption, recycling or having energy efficient homes. Many applicants expressed that this is not enough and they wanted to push themselves to do more. While the car is a norm, it also clashes with ideals of having a sustainable lifestyle, which motivated some applicants: *“we are members of the green party and are ashamed to have such an old car but we haven’t found any good alternative”* and *“we are environmental geeks who are ashamed of our car”*.

Social responsibility was also given as a reason for wanting to get rid of the car. Some applicants thought it is everyone’s responsibility to contribute to a better world, particularly related to life in cities: *“We need to change our behaviour if we are going to continue living in big cities”*. Applicants were also thinking about their children’s future. A family with three-year-old twins wanted to participate in the project *“to contribute to a cleaner world we can give to our children”*.

The motivations of the three families selected for the project were very much in line with the environmental and societal concerns described above. Two of the families were also motivated by the opportunity to inspire others to find alternatives to owning cars. These concerns are elements on both an individual and a societal level; they personally cared about doing good for the environment at the same time as they were bothered by the car norm that is dominant in many parts of society. In addition, one family not only had environmental concerns, but also a wish to scale down and live a life with fewer things. One family particularly disliked the hassle of parking and maintaining the car and also gave economic reasons for wanting to not own a car. This motivation concerns the practicalities around the car and can be seen as belonging to elements of *near materiality*.

New practices

During the car-free year, the light electric vehicles became significant elements in the new practices of the three families. However, these vehicles alone could not compensate for the absence of the car. For longer trips, the families travelled by train and they adapted their holiday plans to their new situation. There was an increase in online shopping, which replaced the need of taking the car for buying groceries or larger items needed for the household: *“We have ordered everything online. This works well as long as you don’t forget something.”* From a practice perspective, the tools and services for online shopping with home delivery can be considered elements of *near materiality* that facilitate car-free living.

For the children, the car-free year led to more responsibility of walking, biking or travelling by public transport by themselves. These practices depended on elements related to the existing infrastructure and well working and reliable public transportation, widely used by different groups of people, in Stockholm. Walking, biking, running and using public transport also



Figure 3. Photo posted on the project’s Facebook page by one of the families who bought a second-hand table and took it home with their box bike.

complemented the use of the electric vehicles for the parents. When nothing else worked, such as when going home late at night after a company party or when the toilet broke down and they urgently needed a new one, they made use of taxi services or borrowed cars. The families sometimes also skipped visiting friends or going to activities at places that were difficult to get to by the electric vehicles or by public transport.

For all the families, the car-free year led to significantly more biking: to work, to school and to evening and weekend activities. The families also, to a greater extent than before, biked during the cold and dark winter months. To overcome the barrier of winter biking, and to make it a new practice, the participants had to acquire knowledge about what equipment to use to make it feel safe and more comfortable. Examples of means they used to increase their knowledge were: a Facebook group for box bikes, advice in bike stores and discussions with experts tied to the project. In this way, the combination of individual elements (the new knowledge) and material elements, such as winter tires, good clothes and strong bike lights, enabled the new practice.

For the family with younger children, the electric box bikes worked particularly well as a replacement for the car. They found that the box bike had the car’s flexibility; it leaves when one wants it to and takes the rider to the exact destination of their choice. Compared to public transport, the box bike was also much more convenient for “serial activities”, such as when picking up the children from school, dropping off one child at a friend’s place, then stopping by the grocery store, before finally going home. In addition, the entire family of two adults and three children could fit on the three-wheeled box bike, which the family named “the truck”, and the electricity made the load manageable. The storage capacity was also welcome when buying second hand furniture (see Figure 3).

Planning

Irrespective of transport mode or trip purpose, the new practices required considerable amounts of planning. For

occasions when a car was needed, such as when transporting furniture to the summer house or for renovating at home, the families tried to coordinate activities and use the car for many different things. While they previously might have taken the car the first time they came to think of something they needed, they now thought twice and waited for several reasons and a possibility for coordinating trips, before actually using a car. Going on holidays without a car required planning in terms of choice of destination, route planning and finding out how to manage the luggage. This planning was not only focused on time aspects, but also on costs. When fuel cost was compared to the cost of train tickets for the entire family, the train was sometimes perceived as an expensive option. However, the fuel cost is only a part of the actual cost of owning and using a car, and even though the family members were aware of this, they tended to forget it when evaluating different transportation options.

The trips within the city, including the daily trips, also required planning. The families had to find suitable routes for the different types of vehicles since, for example, the four-wheeled motorcycle was not comfortable to drive on highways and they wanted to avoid biking with children on city streets without dedicated bike lanes or with too much traffic. They also needed to plan their trips by public transport and to learn about different options. As support for these decisions they used different types of digital travel planning tools. Such tools can be regarded as *near materiality* elements, closely linked to elements of *infrastructure*. These tools also have implications on the *individual's knowledge*, since they helped the families learn about new ways of getting around. However, the planning was not only related to route, time or transportation mode, but also, for example, to ensuring that the children had something to eat between school and after-school activities, to charging the vehicles and taking the charger to work if necessary, and to taking useful equipment for the trip, such as warm and protective clothes and gloves when biking in cold or wet weather.

With the car gone, the families could no longer use it to compensate for poor planning or to manage unexpected events. Previously, the car was not only used when it was the most advantageous option but also for occasions when the original plan failed: when a child missed the bus to an activity, when the family was too late for walking or when the weather was bad. In this sense, the car was associated with flexibility. However, the lack of flexibility also turned out to have positive sides. One family found that their trips became less stressful when they did not have a backup option: *"it saves time and is more efficient to not have that flexibility"*.

The norm of the car

Owning a car and not owning a car can both be provocative. Challenging the car norm can be sensitive in some groups, while other groups have strong norms

linked to sustainable lifestyles and find car-free life perfectly normal. Already when the call for participants was posted on Facebook, we received comments that were strongly against the idea of not owning a car as well as comments that did not see any problem in being car-free.

Examples of pro-car posts were: *"Of course we can manage one year without a car. We can also manage one year without a job, without an apartment, without a phone, without tv, without meeting family and friends. The question is why one would make it so hard on purpose."* and *"I don't go anywhere without a car. Could maybe consider going by bike if it wasn't for the wholesome label that comes with the bike. It almost makes me puke."*

Examples of comments in favour of not owning cars were: *"Of course we live without a car. We are modern people, right? Walk to kindergarten, dog daycare and work. Or bike sometimes. If we need a car we rent it."* and *"It has not been a problem at all to be extremely mobile, with family and without a car. Would rather want to try if I really would stand a year with a car and all misery that brings in terms of high costs, increased travel time, traffic jams, hunt for parking space, damage to the environment and worsened health."*

The three families in the project were all aware of that their participation in the car-free year project could be provocative and they were careful not to judge car owners. While they still thought there is a lot of unnecessary car use in cities, they also recognised that there are situations where cars are necessary, such as when you live or work in places with poor public transport or in the countryside. Nevertheless, they sometimes got the impression that relatives, friends and colleagues who own cars felt criticised by their participation in the project: *"They [some car owners] cannot see that society could be better by people living car-free. They think society should adapt to make it easier for cars to get around."* To make their car-free lifestyle less provoking in the contexts where the car was a norm, one family stressed that they were part of a *research* project. Another family said they joined the project for economic reasons: *"I have to say that I need to live car-free because it is too expensive [to have a car]. This argument is easily bought. That it would be for environmental reasons is really provoking."*

Practical challenges

One of the major challenges for the three families in the car-free year was related to taking the children to various activities, particularly sports practices. Another significant challenge for two of the families was to get to their summer houses and, once there, to do grocery shopping, to get to activities, and to visit family and friends nearby. In addition, two of the families had renovation plans already when the project started and had to figure out ways of managing that with minimal use of cars, which was not always easy: *"Renovating is difficult. It is really*

hard if you are not a builder to plan exactly what and when things are needed [to know what to order online]. It is frustrating and lead times are long.” The renovations also led to a need of transporting old stuff *away*, which was more difficult and more expensive than getting things delivered *to* the home. For the families living in apartment buildings it was easier to deal with bulky waste and recycling, since that was provided in the houses or close to the buildings. However, for the detached housing areas and the summer houses, where owning a car is a norm, it was considerably more challenging to handle recycling, bulky waste and garden waste without a car.

The challenges increased during the winter season: the families needed good clothes for cycling, the bikes needed winter tires and strong bike lights, and the parents were worried about driving the vehicles in snowy or icy weather. Using the vehicles in the city, particularly the box bikes, was sometimes also challenging. Even though there are bike lanes in many places in and around the city, not all of them were broad enough for the box bikes and poor maintenance made some bike lanes difficult to use. These issues often forced the families to ride the box bikes on the roads with the cars, where they felt out of place and vulnerable: *“Sometimes you feel a bit like you are in the face of car drivers. Like you’re making a statement. Sometimes you are in the way: not being able to drive that fast and being rather wide. You are somewhat unpredictable because they are simply not used to seeing such a vehicle.”*

Emotional challenges

Many of these challenges of how to solve practical matters were expected beforehand, but the challenges also turned out to have more emotional aspects that the families realised along the project. Without the car, one family could no longer help a grandmother with shopping and transportation to family gatherings. Instead, other relatives had to take the grandmother more often, and the family was unhappy about not being able to help as usual. In another family, one of the teenagers considered quitting a sports activity that required one hour of travelling with public transport each way, and the parents felt bad about not being able to help with driving.

One family was concerned that other parents would consider it bad parenting to let the children travel alone by public transport: *“with the lifestyle they have, you just don’t do it that way [let the children go by public transport]”*. At the same time, the family did not want to always be the one asking other parents in the sports teams for rides. However, in one team this was less of a problem since the team used an online tool for ridesharing, which was part of the process of signing up for activities: *“They register to matches through their website. You fill in if you’re going to attend, if you have car or not and if you have space in the car. So getting a lift with someone is resolved incredibly naturally in this team.”* In addition,

not having a car made the families more dependent on relatives and friends for the few occasions when they needed a car, and one family pointed out the negative feeling of owing someone after borrowing their car.

These feelings are elements of the *individual’s values* of being able to help as well as elements of norms and social values. The participants felt a sense of not fitting in and following the norms, since they always had to ask for help, without being able to offer help.

Benefits of not owning a car

The car-free year not only brought challenges, but also many positive experiences. The family members valued spending time with each other, and the increased use of train, instead of car, for longer trips provided new opportunities for this. On the train all family members could enjoy the trip, since none of the parents had to focus on driving. One family also found that travelling by train, and sitting facing each other, encouraged more conversations compared to travelling by car: *“You rarely sit together the whole family for over two hours and talk. It is not the same when you are going in a car because then the children listen to [music on] their mobile phones.”* The box bike parents had similar experiences when biking with their children sitting in the box in front of them.

Another clear benefit for the parents who biked was daily exercise, which they otherwise found difficult to fit into their busy schedules. With the bike they also got to spend more time outdoors and they enjoyed the fresh air and sunlight. These are all aspects of biking that contribute to defining the bike as a healthy means of transportation. In addition, the families could choose more scenic routes with the bike than by car and enjoy the trip through a positive experience of nature.

Biking was also given as an example of how to get to know a city better and to “make it your own”. Even though lack of knowledge of the city was a barrier to travelling by bike to new places, biking was at the same time perceived as a good way of extending the knowledge. The parents were particularly keen on that their children should learn to find their way, both for practical reasons but also for them to feel “grown-up” and to feel that the city is “their city”.

POSITIVE AND NEGATIVE EXPERIENCES OF THE NEW PRACTICES

Just as a car can be used in many different practices, not owning a car affects numerous practices. The families have changed how they go to work, run errands, go on holidays and spend time with family and friends. Different practices can also have shared elements [22], which we have seen for example in “good planning skills” being part of several practices and in the norm “not having a car is odd/extreme” being present in many different situations.

Social Structure (Norms and shared ideas)	Infrastructure (Infrastructure and services in the city)
(+) Biking is healthy (4) (+) Owning a car in a big city is not “green” (3) (-) A sustainable lifestyle is odd/extreme (-) Not having a car is odd/extreme (1, 2, 3, 4) (-) Asking for help leads to owing someone (3) (-) Young children should not travel alone with public transport	(+) Frequent public transport (+) Easy access to household waste recycling systems (+) Dedicated bike lanes (-) Unreliable or crowded public transport (-) Poorly planned/maintained bike lanes (1) (-) Poor access to recycling systems for bulky waste (2)
The Individual (Skills, values and knowledge)	Near Materiality (Technologies, stuff and services)
(+) Good planning skills (+) Caring about the environment (+) Wish to scale-down (+) (-) Knowledge of the city (4) (+) (-) Valuing spending time with the family (4) (-) Lack of knowledge of equipment for winter biking (1)	(+) Appropriate biking equipment (1) (+) Facebook community for box bikes (1) (+) Online system for ridesharing (3) (+) Online services for shopping (2) (+) Home delivery services (2) (+) (-) Light electric vehicles (1, 3, 4) (+) (-) Travel planning tools (1, 4)

Table 2. Elements of car-free practices that the families experienced as positive (+) or negative (-). The numbers next to the elements indicate which of the design opportunities below these elements are parts of.

During the car-free year the families experienced some elements of the new practices as positive while other elements were related to negative experiences, see Table 2 for an overview. The overview is in no way a complete picture of all elements involved in all transportation related practices of the families – that would be practically impossible. Instead, we selected elements that occurred frequently or that we found particularly interesting or inspiring for future design work.

We chose to highlight the positive and negative experiences related to the elements since we believe that this is useful not only to understand the practices of the three families in the study, but also to investigate how other people may be recruited to, or deterred from, sustainable transportation practices. Many of the elements can, in different contexts, be either positive or negative, depending on the quality of the element in the specific context. Good knowledge or well working infrastructure was related to positive experiences, while lack of knowledge or poor infrastructure led to negative experiences. For the analysis we chose to include the most dominant characteristic of the element in the context of the three families’ practices in Stockholm. In addition, some elements, such as the light electric vehicles, were associated with both positive and negative experiences, since they on one hand worked very well for the families in many situations but on the other hand added new challenges that the families found frustrating.

It is clear that many elements of transportation practices are not directly in the hands of HCI. Nevertheless, we believe there are opportunities for HCI to support change

on a societal level, as well as there are risks of reinforcing unsustainable norms, by the way technologies and services are designed.

OPPORTUNITIES FOR DESIGN AND ICT TO SUPPORT SUSTAINABLE (TRANSPORTATION) PRACTICES

ICT and related services were very present in the *near materiality* of the families’ new practices. We also found examples of how ICT supported the families in overcoming negative experiences on societal, infrastructural and individual levels. In addition, we identified opportunities for ICT to further strengthen elements related to positive experiences or to challenge elements that may deter people from adopting sustainable transportation practices. In Table 2 it is indicated which the key elements are for each of the design opportunities in this section.

From our case we have also identified a few more general themes that may inspire designers concerned with sustainability but not necessarily with transportation. Firstly, we believe that design work aiming at supporting transitions towards sustainable practices should be characterised by *designing at the tension between the odd and the norm*. When designing something for “the odd” there is a risk of further distancing it from the norm, which may work against the goal of making the odd more mainstream. Secondly, we want to re-emphasise, and give examples of, what many others already have proposed: *designing with a focus beyond the individual*. Finally, we see opportunities for sustainable HCI in *designing for alternatives to resource optimisation*, to highlight values that are important for sustainable practices. These themes

are further discussed below through the example of transportation.

(1) Supporting odd types of vehicles

Many of the challenges the families faced with their new vehicles were related to the city infrastructure not being adapted to light electric vehicles; the families were the odd ones on the roads and in the parking spaces. Just as bicycles were strange vehicles when they were introduced two centuries ago, so are box bikes, electric bikes and other light electric vehicles today.

In transportation, ICT already to some extent supports sustainable choices, for example through travel planning tools that suggest suitable bike routes. However, the information such tools provide may be insufficient or inadequate for electric bikes or box bikes. Even though a box bike is per definition a bike, it has very different properties than a regular bike, mainly due to its size and shape. For example, a bike route that works well for a regular bike may be too narrow for a box bike, and obstacles such as roadwork pose a greater challenge for a larger bike. Consequently, travel information for box bike users could be improved by including if the bike road is “box bike size” and if there is ongoing roadwork.

Another aspect travel planning tools for electric bike users could capture better is the different experience the electricity provides. With an electric bike it is possible to travel faster and at a more constant speed compared to a regular bike, even if the route is hilly, which reduces travel times and the cyclist gets less sweaty. Since convenience has been identified as an important factor for transportation choices [24], such benefits should be highlighted in the design of travel planners. There are examples of dedicated travel planners for electric bikes, which for example take weather conditions into account [26]. However, when designing for the tension between the odd and the norm it becomes important to integrate such solutions with mainstream travel planning, not only to make electric bike users feel less odd but also to challenge current transportation norms and make the benefits of the alternative visible also to people who are currently choosing “normal” modes of transportation.

Specific information for odd travel modes can be provided through online communities, such as the Facebook group for box bikes that one of the families followed. Apart from practical tips, these types of groups can also contribute to a community feeling that encourages use of the specific mode of transportation [1]. From a practice perspective, the Facebook group both addresses elements at the individual level, by increasing knowledge that facilitates the use of the box bikes, and elements at the societal level, by providing a forum that challenges the car norm and suggests alternatives. Such communities could be more easily created and spread by involving actors “beyond the individual”. Based on our data we see opportunities in engaging workplaces, schools

and sports teams as creators and facilitators of such norm-challenging digital forums, as these are situations where transportation discussions often occurred and the oddities were exposed (and also spread). This knowledge exchange could be combined with services, such as joint bike maintenance or the provision of light electric vehicle leasing contracts by workplaces.

(2) Providing services for transporting stuff away

Transportation is not only about moving people between places and activities, but also about moving all sorts of stuff. Without the car, the families changed their shopping practices and in many cases ICT, in the form of online services for shopping, was a part of the new practices. Home delivery services were often free or provided for a small fee, which further enabled online shopping.

While the online shopping providers did not let the families’ lack of transportation get in the way of shopping, the families faced greater challenges when things needed to be transported away from the home, particularly for the case of disposing of bulky waste. There are online services for ordering or coordinating such transportations, but they are less accessible and not as integrated into current practices as home delivery services. Renting a car or buying services to have something transported away may also seem expensive, particularly when it is compared to home delivery prices, where the actual delivery cost often is hidden in the cost of the product that is being bought and not explicitly labelled as delivery.

One existing services for coordinating transports is provided by the company Baghitch³. It acts as a matchmaker between people who are driving and have space for taking something in the car, and people who need to transport stuff. However, to become more accessible such services need to be better integrated into the situations where transportation is needed and may need to involve other actors than individuals. In the case of disposal of bulky waste, the City of Stockholm, which provides the physical infrastructure for recycling, could complement its recycling service with digital services for coordinating transports, and at the same time challenge the norm that all households in areas with detached houses have access to cars. ICT coordination of transporting stuff away could also be designed for delivery companies or construction workers who already transport stuff as part of their business.

(3) Facilitating helping

One barrier to not owning a car is the norm in Western societies that asking for help leads to owing someone. Lately we have seen an increasing number of ICT enabled services that aim to facilitate the sharing of for example cars or homes between strangers. However, these

³ www.baghitch.com

typically include predefined rules and clear transactions (the user pays for the service) and no one is left in debt. In our study we found an interesting case in supporting people in being helped with things they could not manage without a car, but by friends, colleagues or other acquaintances.

One example of current technology, facilitating this type of helping between people already acquainted, is the system for signing up for sports activities and coordinating ridesharing, which was used by a sports team of one of the car-free families. By encouraging people to offer help with rides, the system partly hides the oddness of not having a car and makes it easier for car-free families to get a ride to the activities. Another opportunity in the design of ICT solutions is to turn around the roles of the helper and the person being helped. It is questionable whether it is always the person not owning a car who is helped by a car owner, when borrowing a car or getting a ride. A person without a car could, for example, help a car owner to get to work faster in cities with dedicated lanes for car-pooling. Car-free people can also help car owners to lower their carbon footprint (from the embodied emissions of the production and transportation of the car), and perhaps also reduce any associated feelings of guilt for owning a car in a city.

There is, however, a risk that such technologies reinforce the role of the car as the normal mode of transportation. In the case of the ride-sharing tool for sports teams it also means that families without cars cannot contribute to solving the team's transportation needs, and in the long run they might still be considered the odd ones. To better balance the tension between the odd and the norm, the ride-sharing tool could include also options to offer transportation help for example by taking the children by public transport or by box bike. We believe that this tension between the odd and the norm, and the risk of unintentionally reinforcing norms, is important to consider also for other sharing services that aim to support sustainable practices.

(4) Optimising beyond time

The families' choice of not owning a car was often questioned by other families who wondered how they had time for all the hassle. While many trips by public transport or bike are faster, or equally fast, as the same trip by car, there are still many situations where the car clearly is the fastest option to move from one place to another. Time, as in number of minutes, is also very dominant information in travel planning tools [13]. However, when optimising primarily for time, other values that are important elements in sustainable transportation practices are neglected.

If certainty of the travel duration is included as optimisation criterion (higher for bikes than for cars due to unforeseen traffic jams), cars may not be necessarily so attractive. The families also mentioned other, more subtle,

criteria: getting physical exercise and being outdoors in the fresh air and sunlight, being with the family without having to focus on driving, sitting face-to-face and talking while travelling, driving a scenic path which can only be approached by bike and getting to know the city better. Finally, our participants suggested that time optimisation and too much flexibility may lead to stress: leaving by car for a long trip "as soon as possible" may be more stressful than taking a train at a certain time.

These are all opportunities for ICT and travel services. Currently in travel planning tools, it is not at all visible that replacing a 20-minute car trip with a 40-minute bike trip means "winning" 40 minutes of exercise, sunlight or increased knowledge of the city, instead of "losing" 20 minutes in the car. There might also be possibilities of enhancing positive experiences of sustainable transportation by linking travel planning tools to other services, such as fitness tools or time reporting systems at workplaces.

A resource efficiency perspective on optimisation may leave out values that are important elements also for other types of sustainable practices, for example related to food or consumption. We believe that designers must be aware of this tension between traditional optimisation and sustainability that is present in many practices.

CONCLUSION

In this paper we presented a case study of three families who radically changed their transportation practices by replacing their car with light electric vehicles for one year. We used the case of transportation to exemplify how practice theory can be applied to sustainable HCI and to inform and inspire design of digital services supporting transitions towards sustainable practices. In the study, positive and negative experiences related to elements of sustainable transportation practices were identified. We have shown how design for sustainability can be focused on overcoming negative experiences, spreading elements associated with positive experiences and turning negative experiences into positive ones. We believe that making both positive and negative experiences explicit is useful in order to encourage a focus not only on how to address problems, but also on how to use ICT to build on positive experiences that may be useful for recruiting people to sustainable practices. Furthermore, we suggest sustainable HCI to focus on the *tension between the odd and the norm*. This may include new ways for ICT to approach optimisation as well as provide opportunities to identify actors, beyond the individual, who are crucial for the transformation of the odd into norms.

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REFERENCES

1. Caroline Bartle, Erel Avineri, and Kiron Chatterjee. 2013. Online information-sharing: A qualitative analysis of community, trust and social influence amongst commuter cyclists in the UK. *Transportation Research Part F: Traffic Psychology and Behaviour* 16: 60–72. <http://doi.org/10.1016/j.trf.2012.08.013>
2. Maria Börjesson, Jonas Eliasson, Muriel B. Hugosson, and Karin Brundell-Freij. 2012. The Stockholm congestion charges-5 years on. Effects, acceptability and lessons learnt. *Transport Policy* 20: 1–12. <http://doi.org/10.1016/j.tranpol.2011.11.001>
3. Efthimios Bothos, Dimitris Apostolou, and Gregoris Mentzas. 2013. Choice Architecture for Environmentally Sustainable Urban Mobility. *CHI 2013*, 1503–1508.
4. Barry Brown, Stuart Reeves, and Scott Sherwood. 2011. Into the Wild: Challenges and Opportunities for Field Trial Methods. *CHI 2011*, 1657–1666.
5. Hrönn Brynjarsdóttir, Maria Håkansson, James Pierce, Eric Baumer, Carl Disalvo, and Phoebe Sengers. 2012. Sustainably Unpersuaded: How Persuasion Narrows Our Vision of Sustainability. *CHI 2012*, ACM, 947–956.
6. Caspar G. Chorus, Eric J. E. Molin, and Bert Van Wee. 2006. Use and Effects of Advanced Traveller Information Services (ATIS): A Review of the Literature. *Transport Reviews* 26, 2: 127–149. <http://doi.org/10.1080/01441640500333677>
7. Carl DiSalvo, Phoebe Sengers, and Hrönn Brynjarsdóttir. 2010. Mapping the landscape of sustainable HCI. *CHI 2010*, ACM, 1975–1984. <http://doi.org/10.1145/1753326.1753625>
8. Paul Dourish. 2010. HCI and environmental sustainability: the politics of design and the design of politics. *DIS 2010*. <http://doi.org/10.1145/1858171.1858173>
9. Federal Highway Administration. 2010. *2009 National Household Travel Survey*.
10. Jon Froehlich, Tawanna Dillahunt, Predrag Klasnja, et al. 2009. UbiGreen: Investigating a Mobile Tool for Tracking and Supporting Green Transportation Habits. *CHI 2009*: 1043–1052. <http://doi.org/10.1145/1518701.1518861>
11. Maria Håkansson and Phoebe Sengers. 2013. Beyond Being Green: Simple Living Families and ICT. *CHI 2013*, 2725–2734. <http://doi.org/10.1145/2470654.2481378>
12. Tuillia Jack. 2013. Nobody was dirty: Intervening in inconspicuous consumption of laundry routines. *Journal of Consumer Culture* 13, 3: 406–421. <http://doi.org/10.1177/1469540513485272>
13. Anna Kramers. 2014. Designing next generation multimodal traveler information systems to support sustainability-oriented decisions. *Environmental Modelling and Software* 56: 83–93. <http://doi.org/10.1016/j.envsoft.2014.01.017>
14. Lenneke Kuijer and Annelise De Jong. 2009. A practice oriented approach to user centered sustainable design. *Ecodesign 2009 Conference, Saporu, Japan*: 1–6.
15. Lenneke Kuijer and Annelise De Jong. 2012. Identifying design opportunities for reduced household resource consumption: exploring practices of thermal comfort. *J. of Design Research* 10, 1/2: 67. <http://doi.org/10.1504/JDR.2012.046140>
16. Lenneke Kuijer. 2014. Implications of Social Practice Theory for Sustainable Design.
17. Kari Kuutti and Lj Bannon. 2014. The turn to practice in HCI: towards a research agenda. *CHI 2014*, 3543–3552. <http://doi.org/10.1145/2556288.2557111>
18. Johanne Mose Entwistle, Mia Kruse Rasmussen, Nervo Verdezoto, Robert S Brewer, and Mads Schaarup Andersen. 2015. Beyond the Individual: The Contextual Wheel of Practice as a Research Framework for Sustainable HCI. *CHI 2015*.
19. Åsa Nyblom. 2014. Making plans or “just thinking about the trip”? Understanding people’s travel planning in practice. *Journal of Transport Geography* 35: 30–39. <http://doi.org/10.1016/j.jtrangeo.2014.01.003>
20. Sebastian Prost, Johann Schrammel, and Manfred Tscheligi. 2014. “Sometimes it’s the weather’s fault”: sustainable HCI & political activism. *CHI 2014*, 2005–2010. <http://doi.org/10.1145/2559206.2581358>
21. Kakee Scott, Conny Bakker, and Jaco Quist. 2012. Designing change by living change. *Design Studies* 33, 3: 279–297. <http://doi.org/10.1016/j.destud.2011.08.002>
22. Elizabeth Shove, Mika Pantzar, and Matt Watson. 2012. *The Dynamics of Social Practice: Everyday Life and how it Changes*. SAGE Publications.
23. Elizabeth Shove and Gordon Walker. 2010. Governing transitions in the sustainability of everyday life. *Research Policy* 39, 4: 471–476. <http://doi.org/10.1016/j.respol.2010.01.019>
24. Jana Sochor, Helena Strömberg, and Marianne Karlsson. 2014. Travelers’ motives for adopting a new, innovative travel service: Insights from the UBIGO field operational test in Gothenburg, Sweden. *World Congress on Intelligent Transportation Systems*.
25. Yolande Strengers. 2011. Designing eco-feedback systems for everyday life. *CHI 2011*, ACM Press, 2135–2144. <http://doi.org/10.1145/1978942.1979252>

26. Irina Tal, Aida Olaru, and Gabriel Miro Muntean. 2013. eWARPE - Energy-efficient weather-aware route planner for electric bicycles. *International Conference on Network Protocols, ICNP*. <http://doi.org/10.1109/ICNP.2013.6733680>
27. Trafikanalys. 2015. Resvanor. *RVU Sverige 2011-2014 Den nationella resvaneundersökningen*. Retrieved August 12, 2015 from <http://www.trafa.se/statistik/resvanor/>
28. John. Urry. 2004. The “System” of Automobility. *Theory, Culture & Society* 21, 4: 25–39. <http://doi.org/10.1177/0263276404046059>
29. Bas Verplanken, Henk Aarts, and Ad Van Knippenberg. 1997. Habit, information acquisition, and the process of making travel mode choices. *European Journal of Social Psychology* 27, 5: 539–560. [http://doi.org/10.1002/\(sici\)1099-0992\(199709/10\)27:5<539::aid-ejsp831>3.0.co;2-a](http://doi.org/10.1002/(sici)1099-0992(199709/10)27:5<539::aid-ejsp831>3.0.co;2-a)