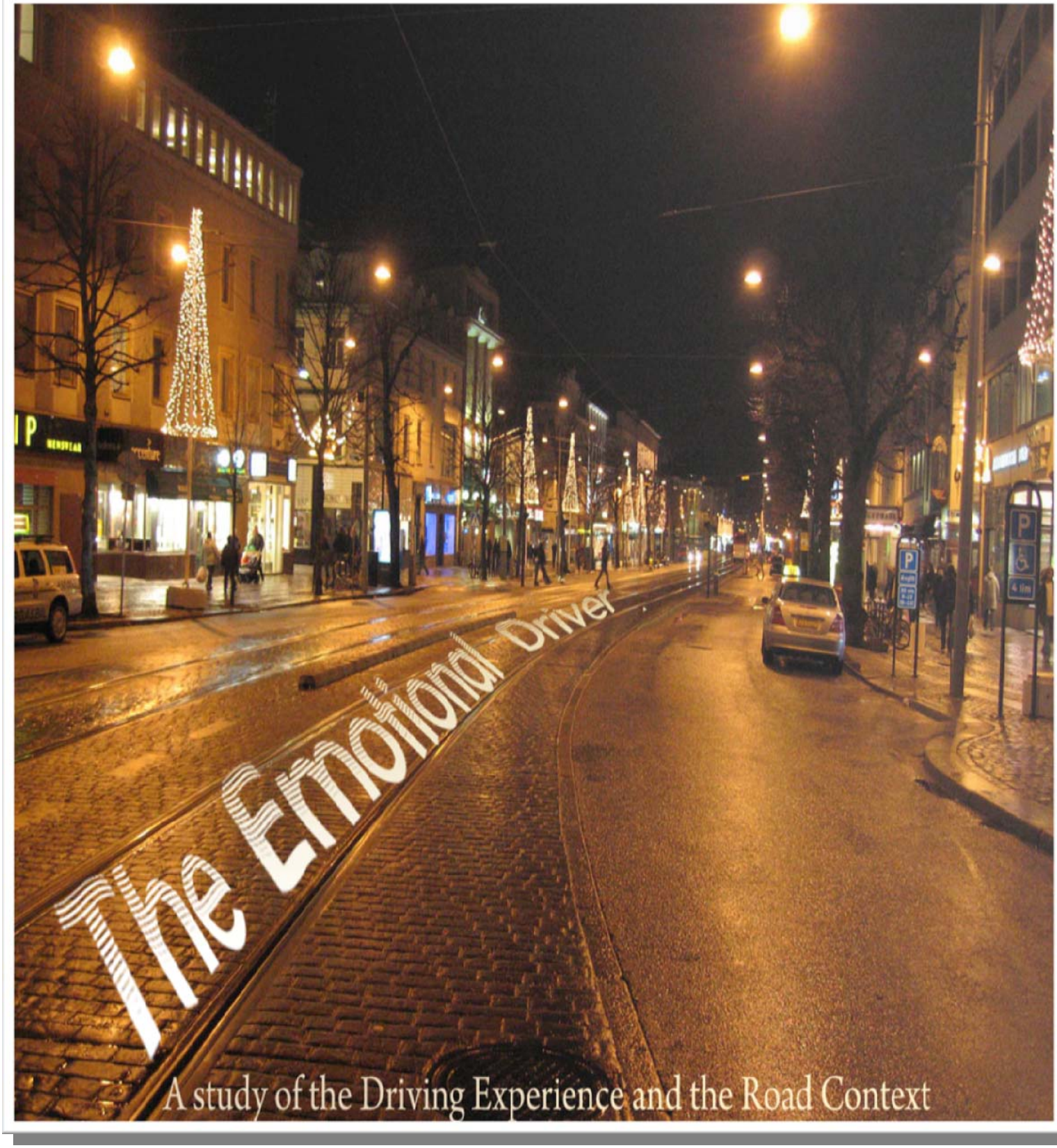


Julio Angulo

Master Thesis in Ubiquitous Computing

Master Thesis
Computer Science
Thesis no: MSE-2004:xx
June 2007

The Emotional Driver

A Study of the Driving Experience and the Road Context

Julio Angulo

School of Engineering
Blekinge Institute of Technology
Box 520
SE - 372 25 Ronneby
Sweden

This thesis is submitted to the School of Engineering at Blekinge Institute of Technology in partial fulfillment of the requirements for the degree of Master of Science in Ubiquitous Computing. The thesis is equivalent to 20 weeks of full time studies.

Contact Information:
Author(s):
Julio Angulo
Address: Magistratsvägen 55 N121, 226 44, Lund Sweden
E-mail: juan05@student.bth.se

External advisor(s):
Oskar Juhlin
Company/Organisation: Mobility Studio, Interactive Institute
Address: Kistagången 16
Phone: +4686331500

University advisor(s):
Marcus Sanchez-Svensson
School of Engineering, BTH

School of Engineering
Blekinge Institute of Technology
Box 520
SE - 372 25 Ronneby
Sweden

Internet : www.bth.se/tek
Phone : +46 457 38 50 00
Fax : +46 457 271 25

Contents

1 Introduction **1**
1.1 Intentions and Relevance of this Study 1

2 Background: Theory and Concepts **4**
2.1 Related Studies of the Roads and Road Users 4
2.2 The Concept of a *Road User* and a *Road* 7
2.2.1 Road Users 7
2.2.2 The Road 8
2.3 Ubiquitous Computing for the Driving Experience 10
2.3.1 Theories on Context 12

3 Emotions and the Driving Experience **16**
3.1 On Emotions and Personal Experiences 17
3.2 Choosing A Model for Interpreting Driving Emotional States 19
3.3 The Challenge of Capturing the User Experience 22
3.4 Importance of People's Experiences When Designing for Technology 23

4 Research Methods and Experiments **26**
4.1 Cultural/Urban/Technology Probes 27
4.1.1 Postcard technique 28
4.1.2 Road Picture Gallery 31
4.1.3 Web-logs as means of finding strangers' driving experiences 34
4.1.4 Findings from the Cultural Probes 37
4.2 Ethnography and other observations 38
4.2.1 Talk-Aloud-Protocol 39
4.2.2 Shadow method 41
4.2.3 Findings from Ethnography Methods 43
4.3 Experience Sampling Method 44
4.3.1 Findings from the Experience Sampling Method 48
4.4 Summary 49
4.4.1 Comparison of Methods 49
4.4.2 Summary of the analysis of the results 51

5 On the Importance of Light **53**
5.1 Time of the Day 54
5.1.1 Daylight 54
5.1.2 The Blinding Sun 55
5.1.3 Night Driving 56
5.2 Lights emitted by other Cars 57
5.3 Lights from the Road 58

6 On the Importance of Sound **60**
6.1 Types of Sounds 61
6.1.1 Own Vehicle's Sounds 62
6.1.2 Other Vehicle's Sounds 64
6.1.3 Sounds from the External Environment 64
6.2 Conclusions 65

7 On the Importance of Landscapes and Architectures **67**
7.1 The View of Landscapes and Architectures 67
7.1.1 Appreciation and Depreciation of the Scenery 68
7.1.2 Personal Attachments to Road Segments 70
7.2 The Feeling of Motion and Space 71
7.2.1 Feelings from Spatial Perceptions 71

8 On Drivers Interaction **73**
8.1 The Unnecessary Traffic 74
8.2 Road Interactions 76
8.2.1 Relative Position 76
8.2.2 Speed 77
8.2.3 Communication Between Drivers 77
8.3 Interactions Inside the Car 79

9 A Ubiquitous Road - Implications for Applying Technology on the Road **80**
9.1 New Technological Suggestions Based on Findings of the Study 81
9.2 The Challenge of Evaluating New Technologies 85

10 Conclusions and Final Thoughts **87**
10.1 General Findings and Discussions 88
10.2 Drawbacks and Flaws in the Methodologies 91
10.3 Last Words 92

Appendices **94**

A *Emotional Road* Picture Gallery **95**

B Experience Sampling Method **103**
B.1 Results from the Experience Sampling Method 103
B.2 ReCoded Results from the Experience Sampling Method 103

C Cultural Probes **108**
C.1 Questions on postcards 108
C.2 Text Blogs 108

ABSTRACT

In modern societies the activity of driving has become almost an essential routine. Vehicles are considered by many as indispensable tools for accomplishing their daily tasks and they are the main form of transportation for millions of people. The average driver spends, voluntarily, considerable amounts of time on the road, using their vehicle to transport himself even for small distances and knowing that its use presents him with some form of comfort and convenience; yet, drivers frequently regard their road experience as tiring and fastidious, but their persistence in using their vehicle at every opportunity serves as proof of a pleasurable experience. So far car manufacturers, traffic authorities and designers of technology have been mainly concerned with aspects of the road that ensure drivers safety, increase power engine, provide more comfort, and maintain better streets, etc; however, the actual feelings of the driver as he travels through the streets has not yet been taken into a great account by the developers of the road environment. For this reason this thesis tries to create awareness on the existence and constant presence of people's emotions as they drive, which have the mutual power to influence their action on the road and their driving patterns.

In order to capture a drivers' emotional experience this study uses three main methods. One of them is *Cultural Probes*, consisting of common objects specifically Postcards, Pictures, and Web-logs, to measure unknown factors about the users. The second is the use of *Ethnographic* studies on the driving activities through the use of observations, the popular talk-aloud-protocol and the shadow method. Finally, the *Experience Sampling Method* is used, which tries to captures the experience of an individual as it unfolds in its natural context. With the combined used of these three methods *some* of the main factors of the road's environment that are commonly able to influence the driver's emotions in negative or positive ways were discovered, which include the intensity and type of *light*, the different types and sources of *sound*, the perceivable *landscapes* and surrounding *architectures* and the different kinds of continuously occurring *interactions*. These are just some of the many factors that can influence emotions on the road, and hopefully this study will open the curiosity for a deeper study of these and other aspects of the emotional driving experience.

Keywords: Mobility, Ubiquitous Computing, Road Research.

ACKNOWLEDGMENTS

There are several people who contributed to this study in many different ways.
In particular I would like to thank my supervisors, Marcus Sanchez Svensson for his helpful comments, suggestions, editing, for imparting his valuable knowledge and for believing in me. Oskar Juhlin, whose work and advice were the main motivators of this study, for his patience and for sharing his precious experience. This thesis' worthiness and improvements, if any, are due to their useful advices and involvement.
Thanks to all the participants that volunteered to take part in one of the studied methodologies and that returned material on their valuable emotions as they drove the streets of different cities. Specially helpful was the participation of Camilla Ennerberg, Josefin Resar, Mr. and Mrs. Ennerberg, Xavier Benavides Rel, Maja Djordjevic, Ramon Sebastian de Erice, Andrea Angulo, Rayo Angulo, Jorge Martin Casamayor, and many others who either took pictures, answered questionnaires, were videotaped while driving a car, and the strangers who share their driving experiences through the Internet.
I appreciate enormously the constant support of my friends Rodrigo Santibañez, Denys Bolaños and Laura Estrada, who made life as joyful as it needed to be and who always keep me company physically and spiritually. Also to all the members of my family, Herminia, Alejandra, Lorena, Azucena, Angelica, Ximena, Edith, Felipe, Marco, Daniel, Monica and Jose Angulo, Julieta, Yolanda Reynal, and all the rests who still remember my face and kept pushing me to complete this work as promptly as needed.
Above all, I am especially grateful to my parents, Manuel and Pilar Angulo, for their unconditional monetary, emotional, moral, and professional support, as well as for their patience towards uncertainty, and the unpredictability of their son.
This work has been written for and by all of you!

Chapter 1

Introduction

The road serves multiple purposes. Mainly, it allows us to be mobile, to transport ourselves to work, to school, to our homes. We spend a considerable amount of time on the road, either commuting, working, playing, browsing, wandering, waiting, meeting others, etc. Most importantly, the road is a common place for interaction. The road gives us an opportunity to encounter others, to meet new people and get together with old acquaintances, to communicate our attitudes, beliefs, moods and feelings, and to consciously or unconsciously share and express the commonalities of our road use experience. Through the road cars are displaced as well as are motorcycles, bicycles, skateboards, pedestrians, etc., all of which have to coordinate their movements and based their decisions in a timely fashion depending on the situated actions of other road users around them. They are in constant motion, creating a flow of traffic, and continuously interacting among them throughout their journey to their final destination. This journey occurs never in total seclusion from the road users' immediate environment and its continuously unfolding events, but, quite on the contrary, the road users' journey towards their intended destination fills the road users with emotion and soaks them with information while it is constantly being influenced and affected by the richness of the surrounding context, thus creating a road usage experience.

The intention of this thesis is to convey the important role that the road and its surrounding environment play in our daily lives and our emotional states. In particular, this thesis ventures to study the *experience* of drivers and other commuters as they displace themselves through and between cities. Within this beautiful flow of users streaming through the road there exists an ample set of experiences and a wide range of emotions contained inside each individual, which in coordination forms what we see as the flowing traffic on our streets, avenues and highways. While traversing the road, their emotions are been created, displayed and modified in different ways, by different factors and under ever-changing contexts, consequently affecting the experiences of those proximate others. It is these emotions and experiences which produce, at the core, the factors that this thesis wants to capture, study and understand; it is the aesthetics of traffic flow.

1.1 Intentions and Relevance of this Study

It can be argued that road users, in particular drivers, tend to display a set of emotions caused by the situatedness of the context and, in turn, affect their contexts by unconsciously and unintendedly, but tangibly, expressing their emotions externally. This context entails the immediate physical surroundings as well the other users of the road. In other words, any given driver is brimmed with particular emotions and feelings while sitting in front of his vehicle's steering wheel. The

driver acquires these emotions by what is happening around him, inside and outside of the car, from happiness and pleasure to anger and frustration. Sometimes, drivers tend to express these emotions physically and externally (outside their own body), by singing joyfully, screaming furiously at other drivers or cutting other drivers off aggressively, even when the expression of these emotions is rarely manifested outside the encapsulating vehicle. Some other times those emotions are kept inwardly or hardly expressed, but the driver still possess them even if they are not explicitly communicated. These feelings and emotions could be momentary and transitional, as well as very personal and subjective, but they always influence the driver's perspective on his experience on the road.

This initial ideas and common sense knowledge have shaped the main goals and objectives of this thesis. The first objective is to empirically capture the driving experience with the use of different research methods, and assess or evaluate the methods used, distinguishing which one could be the most appropriate for capturing the users' experience in similar situations, therefore contributing generally to the field of interaction design and other anthropological related disciplines. The driver's experience, in this sense, constitutes the contained feelings and emotional states of the driver that are provoked and expressed by the momentary contexts and its multiple factors.

Consequently, the second objective is to discern and explore some of these different *factors* that compose the driving experience. The findings and general results obtained from the mentioned methods and other observations will hopefully provide cues towards the different aspects of the road that are able to affect the emotions and feelings of the driver. Although it is practically impossible to determine the indefinite numbers of variables that make up the driving experience, it is the intention of this thesis to uncover some of the most prominent of these aspects. Commonly occurring events happening or perceived on the road that can influence the emotions of drivers could possibly include factors like the speed at which the driver is traveling, the number of cars at any given point on the streets, the level of traffic and the perceived sensory inputs, among others that will perhaps be discovered with the results of the study.

Finally, the third main objective is to explore the different ways in which those findings on the drivers' experience can contribute to the design and development of innovative ubiquitous technologies which will have the purpose of supporting and enhancing such experience. One of the goals of ubiquitous computing is to provide its users with seamless interactions with technology while supporting their routinary practices without interrupting their daily activities, in this case, driving. Augmenting the roads and vehicles with calm technologies might prove to bring numerous benefits for road users in terms of their security, mobility, efficiency and, ultimately, their road experience. The vehicle manufactured by Toyota and Sony, the POD [12], which is discussed further in the following chapter, might be a good example of an attempt to tackle, with the use of new technologies, the issue of providing the road user with an experience that goes beyond ordinary commuting without disrupting their normal act of driving. Their ideas and designs are innovative, well thought-through and with an intended purpose, but unfortunately the concept of a vehicle that shows emotion has not been marketed to the public just yet and the question of its success remains unanswered for the moment.

Based on these stated objectives presented above, this thesis will try to unravel the facts that fall under the following hypotheses, which inspired the study and guided the direction of the thesis, and were conjectured according to the thesis' intentions.

The first hypothesis is that drivers' feelings and emotions, i.e. their experience, are influenced by different aspects of the road and the contexts in which they are traveling. Their emotions are transient and can vary through the journey, and the most prominent emotions can be originated before the journey starts by some factor external to the road. Nevertheless, the road can increase or lessen the intensity of those carried emotions. For example, a person might be angry with his boss

at work and still be angry at the end of the day when he gets into his car to start his journey home; this individual's initial driving experience could be characterized by *anger*, but while he travels home he could be amused by the appealing landscape along the road and be happy to listen to his favorite song on the car's radio while he expects to get home to his family and a nice meal. He could also release some anger by speeding up a little if the traffic allows it, therefore lessening the negative feelings of anger and thus enhancing his driving experience. On the other hand, under different contexts, this individual could encounter heavy traffic as soon as he gets out of work, provoking frustration and annoyance as he is stuck inside his car without moving forward, hence amplifying his irritation and perturbing his experience.

It is also hypothesized in this thesis that drivers are hardly aware and accountable for their emotions while they travel. However, their emotions are expressed externally in different ways. This expression of emotions can be noticed by observing the driver's behaviour, such as the movements of his body parts, the speed at which he travels, the form and pitch of his conversational tones, his driving style, etc.

Some methods for capturing the user's experience are better than others. They depend on what is being tried to be captured and the contexts in which it unfolds. Some methodologies suggested in previous research studies might not be appropriate under some circumstances. What is of importance for this thesis is to find an appropriate method that can be applied for the field of mobility. The third hypothesis is that the best result for this case, the study of drivers' emotions, might be obtained not from a single research methodology, but rather by a combined analysis of the empirical material obtained from different applied methods. Data from different methodologies can complement each other and confirm each other's findings, making the conclusions more abundant, reliable and consistent.

These presented objectives and their related hypotheses will lead the direction of this thesis, which has the ultimate goal of capturing those emotions experienced by drivers on the road. The following chapter, Chapter 2, outlines some other related studies of the road and tries to define the notions of a road and a road user, arguing the importance of introducing ubiquitous computing into a road environment. Chapter 3 introduces the concept of experiences and emotions, trying to find a reliable framework for their study. Chapter 4 illustrates the chosen research methods used to capture the driving experience for this study, showing also the procedures carried out towards the goal of obtaining consistent empirical material and the general results concluded from the analysis of that material. The four subsequent chapters, Chapters 5 to 8, present an explanation of the factors found to influence the drivers' emotions, followed by a chapter describing the implications for developing technology to support the driving experience. Finally, a concluding Chapter 10 summarizes the findings and presents some final discussions and thoughts.

Chapter 2

Background: Theory and Concepts

In the task of exploring the factors involved in the driving experience and the emotions that are carried within, it might be wise to look into some previous related research that has tried to tackle the topic of the road and its users from different perspectives. Disambiguating the terms *road* and *road user* might also help us to understand the contexts of the driving activity and the continuously occurring actions under this environment that will be studied and mentioned throughout this thesis. Furthermore, it will serve as the bases to suggest possible technologies that can be deployed for the settings of the road .

2.1 Related Studies of the Roads and Road Users

In recent years, researchers and academics have taken the task of studying different aspects of the road and its users. An influential person on the studies of the roads is the urban planner and Professor Kevin Lynch, who has explored the *looks* of the city, landscapes and other road's surroundings from the perspective of a person inside a vehicle. In their book *The View from the Road* [2] Lynch, Appleyard and Myer invite the reader to consider the possibility of designing roads meant for the drivers' enjoyment. The authors suggest ways in which the construction of streets can be pieces of art, which esthetically enhance the experience of driving by eliciting awareness of the sensations of motion and space. In this way, driving through the streets would become a fascination and be less of a dreadful activity, in which the driver connects with the road and achieves some level of meaningfulness and identity, mainly through the sensory inputs of vision and touch. In his other book, *The Image of the City* [69], Lynch tries to capture the way in which citizens perceive their city. He introduces the terms *legibility*, or the degree in which a city's layout can be recognized and remembered by its dwellers, and *imageability* indicating the qualities of physical objects that leave an impression on the observer's mind who is able to recall them with ease thanks to these physical characteristics; in other words, how easy is for a person to convey a mental image of the layout of a city. Interestingly for this discussion is the innovative ways in which Lynch tries to investigate the image of three different cities (Boston, Los Angeles and Jersey City) from the viewpoint of their inhabitants. He tried to arouse the awareness of the individuals' imageability of their city by performing direct interviews and, more remarkably, asking participants to draw or sketch city plans and fragments of the city's layout [126], which was an attempt at obtaining a true meaning and a realistic idea of how the road users' mind is structured in terms of the way they perceive their city and its space. Lynch's intentions were to obtain empirical material on the imageability of city dwellers on its pure form. In a sense, he was aware of the unreliability

of individuals when trying to express with words their truthful opinions of recollective cognitive processes that tend to be biased towards the noticeable and ordinary, filtering out the details of their experience. Unlike other architects at the time, he regarded individuals' perceptions and experiences of space as important factors in the process of planning and designing cities. Being a creative and smart academic, he created this method for capturing his users' opinions which were very innovative at the time, but his results were criticized by some [126]. Critics of his work argue against the quantity of collected samples, being insufficient to be representative. They also criticize the respondents' unfamiliarity to his used methods, allowing for inexact results and high levels of personal interpretation of the material obtained. However, Lynch was open to criticism and perfected his ideas based on other's comments [126]. His ideas have been seen to be 'ahead of his time', and impressions of his suggestions can be seen in modern research and designs, inspiring scientist on the fields of anthropology, sociology, geography and psychology [126].

Oskar Juhlin and the Mobility Studio in Stockholm have been heavily inspired by Lynch's ideas and proposals, which has led them to conduct vast amount of research on the different factors that constitute the road. Julhin's earlier works include *Traffic Behaviour as Social Interaction -Implication for the Design of Artificial Drivers* [51] and *Road Talk Informatics - Implications for Local Collaboration Along the Roads* [54], where he recognizes the need of road users' communication to achieve coordination, and sees the act of driving as a series of situated actions dependent on their context, which ought to be considered in the design of automated vehicles. In *Bus Talk Informatics* [53] Juhlin deals with the communication of bus drivers by means of technology in order to successfully achieve Integrated Transportation and other needed collaboration of public transportation. *The Interactive Road* project, part of the Mobility Studio, is Juhlin's initiative and vision that "there is much more to traffic encounters than the concerns of mainstream traffic research, the car industry and the road authorities" [52]. This project explores the different aspects of the road in order to support and enhance the road usage experience with the aid of technology so that life on the road becomes more meaningful, fun and interesting. Some prototypes that have been done under this project include *Hocman*, *Roadtalk*, *Backseat Gaming*, *Soundpryer* and *Placememo*, all attempting to provide the road user, in particular the driver, with a more enjoyable experience. In general, Oskar Juhlin has investigated many aspects of the road, such as technology's social impact on the road, mobility of work, and the sociology of traffic and road usage; "his current approach is a combination of ethnographic fieldwork of user practices and design sessions to develop prototypes and services for people on the road" [52].

Motivated by Juhlin's ideas and previous works, Mattias Esbjörnsson has also explored the social aspect of the roads, indicating the measurelessly opportunities of road users for engaging in some form of social interaction with neighboring others and with people at remote locations [28]. He has recognized the variety of activities occurring in the different types of roads and argues that the amount of social interaction that can be observed is becoming more and more common. He concurs with Lynch and Juhlin in that "by studying the social aspects of road use, some of the causes for spending time on the roads may be revealed, and hence inform the design of interesting and meaningful mobile services supporting this practice" [28]. Similarly, Mattias Östergren is another researcher of the road who is interested in studying *Traffic Encounter Interaction* or "the mundane social practice all drivers must engage in when coordinating movement with other copresent drivers...traffic-encounters are generally brief, they happen spontaneously and occur in great numbers." [80].

There are several other research groups, private industries and governmental institutions that are interested in knowing more about different aspects on the road. For example, the field of Vehicle Telematics is concerned with the provision of safety, productivity, mobility and convenience by combining telecommunications and informatics in vehicles, namely augmenting them by integrating cellular communications and positioning systems [111]. The Swedish Institute for Transport and Communication Analysis is an institution that tries to "ensure socially and economi-

cally efficient and longterm sustainable transport resources for the public and industry throughout Sweden" [103]. Their agenda includes reporting public transport and vehicle statistics in Sweden, which indicates the increasing use of automobiles in this country and the preferred method of transport for many. Similar institutions exists in different countries, like *Trasport Canada* (http://www.tc.gc.ca/, 2007), *The U.S. Department of Transportation, Bureau of Transportation Statistics* (http://www.bts.gov/, 2007), the *Mexican Ministry of Communications and Transport* (http://www.sct.gob.mx/, 2007), *Dirección General de Trafico* in Spain (http://www.dgt.es, 2007), *Bundesministerium für Wissenschaft und Verkehr* in Austria (http://www.bmwf.gv.at, 2007), *Bundesministerium für Verkehr, Bau- und Wohnungswesen* in Germany (http://www.bmvbs.de/, 2007), and internationally such as the *World Road Association* (http://www.piarc.org/en/, 2007), the *International Road Statistics* (http://www.irfnet.org, 2007), the *Road Transport Sector* of the European Commission (http://ec.europa.eu/transport/index_en.html, 2007), the *North American Transportation Statistics Database* (http://nats.sct.gob.mx/, 2007), and many more. However, these institutions' main focus of study of the road include transport policies, transport and vehicle telematics, traffic control, road environment and sustainability, road networks, traffic statistics, road design, construction, operation and maintenance, travel patterns and behaviours, road information services, and road and vehicle safety.

Figure 2.1: Toyota / Sony POD

Until today almost no research group or industry has shown interests in studying the emotions of drivers on the road, except perhaps for two current known attempts, *Toyota/Sony's* POD car (Personalization On Demand) and the *School of Design and Built Environment* at the Queensland University of Technology, Australia. Toyota's POD (Figure 2.1) seeks to emotionally connect the driver to his vehicle which is capable of sensing the driver's current emotional states and of externally displaying its own emotions. With a combination of coloured LED displays, headlamps (as its eyes and eyebrows), grille and side mirrors (as its mouth and ears) the POD "shows that it's happy when it is refueled, washed or when it detects the driver approaching by wagging its tail and illuminating to a bright orange. The POD may appear puzzled when looking for a destination, or may look worried when driving in bad weather, poor visibility or on bad roads. As anyone would be, the pod looks tired after long-distance or late-night drives" [12]. This car is able to communicate with its occupants, to express warnings or grace to other cars nearby and to gather information from its surroundings. In order to respond to the user's physiological state, the car uses a series of sensors to identify the driver's affect and to measure his pulse rate and perspiration levels. The conceptual design of the POD had the objective of creating a close affinity of the driver with IT, and to support the relations and lifestyle of Japanese families [125]. However, usability tests and other user evaluations are still unclear and hard to find; instead Toyota presents a few cases and scenarios showing the interaction between the vehicle and its owner. As Juhlin, Toyota and Sony recognize that "in order to realize the public merits envisioned by ITS [Intelligent Transport System] for the car society, there needs to be an understanding of the actions of individual users" [125]. But despite the many features and innovations introduced to the automotive industry by this car, the issue of fully exploring the driver's own feelings and emotions is still left somewhat unresolved by Toyota.

Members of the Queensland University of Technology, however, tried to address this issue and explore the emotional feelings of drivers while interacting with their car and its interfaces [34]. The researchers recruited participants from their University and gather data with the use of interviews, observations and the think-aloud-protocol, and later analyzed the data with a customized version of Russell's model of Core Affect [98] (a model that will be employed and discussed later in this thesis). The researchers tried to "investigate the emotional experience of driving as well as identify unique aspects that influence the overall experience" [34], in particular they analyze the

interaction of participants to the vehicle's dashboard interface and how it influenced their emotional states, but they were not concerned with the effects that the different aspects of the road played in their emotions. Their methods and data triangulation appear to be interesting mechanisms to capture the emotional experience of users' interaction with a product and they will serve as sources of inspiration in the presentation of methods in Chapter 4. They conclude by suggesting that the design of the vehicle's frontal control panel should consider the external context in which the driver is situated, such that in high-traffic situation the vehicle should discourage its driver from interacting with the dashboard and the contrary for low-traffic situations. From this findings it is interesting to observe that what affected the driver's emotions was not so much the interface itself, but rather the external factors on the road (*traffic* in this case) and its contexts which in turn made it harder or easier for the driver to interact with the control panel. Reflecting upon this observation gives us further motivation and excuse to perform a study on the emotions of individuals driving and on the identification of different aspects of the road that directly influence their experience.

Motivations for research on emotions while driving

As observed, Lynch's interests lie on the enhancement of the layout of a city or the improvement of the design of a road which will eventually create a positive experience for the city dweller or the road user. In Lynch's view, these developments would hopefully bring a new meaning of the activities carried out on the road, in particular, the road user's delight for looking at the road and for sensing a smoother flow of motion would increase and be appreciated. Similarly, Juhlin acknowledges the social aspects of the road and is concerned with enhancing the driver's experience with the use of current technologies. He has investigated the technical and social aspects of mobility at work and has developed prototypes that hopefully will serve as the stepping stone for many other practical products. Mattias Esbjörnsson main research focus, under Juhlin's supervision, was the social interaction between road users that is constantly in motion and taking place on the roads.

Note, however, that studying the actual experiences and sensed emotions of road users while navigating through the streets was beyond the scope of Lynch's, Juhlin's, Esbjörnsson's and others' studies, and it is in fact what this thesis will try to capture. It will focus on the yet unexplored studies of the driving experience, the emotions provoked by some aspects existent on the road and how this experience and emotions are able to influence the flow of traffic. As a matter of fact is was Juhlin himself who, having been involved with many studies on the road and been knowledgeable about the current and past research, pointed out the lack of investigation on this topic and motivated the study.

2.2 The Concept of a *Road User* and a *Road*

2.2.1 Road Users

When trying to study the road and its users, it might be a good idea to state what a *road user* constitutes. The term *Road users*, for the purpose of this discussion, refers to any person or even animal who uses the streets as the context for performing activity. Hence road users comprise any pedestrian using the sidewalk to promenade or to cross a street at an intersection; any skateboarder, skater, or biker riding on the street; any bus driver doing his job of transporting people through a route; any merchant using a part of the road to set his stand and sell his goods; any driver displacing himself from one location to another through the city streets by means of a vehicle;

any passenger being driven inside a vehicle; and any other person utilizing the road for any given purpose. However, we will repeatedly use the term road user to refer mainly to the driver of any given vehicle.

An embodied characteristic of road users implies the coordination they have to construct in their series of movements and situated actions in order to achieve harmony and avoid calamities. Cooperation and competition among road users, or some other form of unintended collaboration are constantly taking place on the road, along with the social interactivity that it entails. It could be argued that road users navigate the streets mostly keeping their own well-being in mind, but at the same time knowing that they can achieve this primary goal by being considerate of the others road users immediately around them. In his book, *Smart Mobs - The Next Social Revolution* [93], Rheingold mentions the term *collective action dilemma* which is defined as the perpetual balancing of self interests and the resources created by *some* people but which bring benefits to *all* of them. This concept could be very well applied to the road and its users, whereby traffic authorities and general public both benefit from the creation of roads and its usage. Some few are responsible for the creation of the road, but collectively employ it for their mutual benefit.

In general, road users are an essential part of the road, without them the road wouldn't be needed. Nevertheless, the existence of roads constitutes an essential part of road users' daily lives, without roads the range of possibilities of people to physically act upon their remotely located environments is very constrained.

2.2.2 The Road

Initially, roads were built for trade and transportation of goods. Their construction can be dated back to perhaps 3000 B.C. [114], when old civilizations found the need of connecting cities. Their use became increasingly popular and necessary with the invention of the automobile, which force the improvement and extension of road pathways. With the increased number of highways came an increased number of road users and, therefore, an increase in the importance of the driving experience.

A formal definition of the road might read something like "long, narrow stretch with a smoothed or paved surface, made for traveling by motor vehicle, carriage, etc., between two or more points" [90] or a more complete definition: "A road is an identifiable route, way or path between two or more places. Roads are typically smoothed, paved, or otherwise prepared to allow easy travel; though they need not be, and historically many roads were simply recognizable routes without any formal construction or maintenance. In urban areas roads may pass along and be named as streets, serving a dual function as urban space and route" [123]. But these definitions, as well as the majority of definitions of the road, are rather technical, concerned mainly with the practical purposes served by the road, and therefore letting many other aspects unnoticed and unmentioned.

In general, we can define a road to be a man made public path connecting places and allowing the passage of vehicles and living beings where several communal activities are also taking place in a coordinated manner.

The Importance of the Road as a Medium for Experience

Even when it passes unnoticed, the road is filled with objects and activities that convey information to its users [1]. These objects can be physical, such as traffic signs, speed bumps, street signs,

traffic lights, billboards, lane divisions, roundabouts, light posts, food stands, etc., or they can be subjective, such as speed limits, traffic light's sounds, yielding rights, ambulance sirens, etc. Some of these objects are purposely made and positioned, mainly by businesses or traffic authorities to impose some rules and gain some control over the street environment, and also as a way to aid the driver during his journey, while some other objects or activities are casual and momentarily existent. All these objects' purpose is to transmit some kind of information to the road user, they serve as communicational entities for individuals to coordinate their activities with those of others and provoke awareness in one's own actions while journeying the streets. They can be constantly changing, therefore forcing the road user to update and coordinate his activities depending on the moment-to-moment situation. Thus, this set of combined objects and evolving activities can be seen as an *information space* implying a physical "space filled with shared cues, guidelines, knowledge, advice and other kinds of data where road users are able to navigate while acquiring and distributing this information for themselves and to others using the same roads" [1].

More importantly, these objects and activities are inadvertently able to influence the driver's experience and alter his emotions in negative or positive manners; a possibility that is conceivably passed unnoticed by the authorities in charge. Consider for example, the frustration suffered by a driver traveling through an unknown city and not been able to find proper indications on where to go, or the anxiety felt by a nervous person when hearing the siren of a fire-truck or ambulance behind him, or perhaps the relieving sensation experienced by a hungry and tired driver when encountering a sign indicating the next resting place and restaurant. From happiness to anger, the set of physical entities of the road might be able to trigger emotions in drivers which up to now have been disregarded.

It might be important to take these observations into account due to the fact that many people spend a considerable amount of time on the road and an increasing number of vehicles are found nowadays navigation through the streets [28]. Therefore, road users are been surrounded and impacted by the positioned objects and occurring activities on the road, thus increasing the likelihood that these items will have a substantial influence in the driving experience and the moods of the driver. Considering that substantial efforts are been made in enhancing the technology of the automotive industry, it is very probable that the use of cars and the roads will continue to increase in the following years, hence it would be wise to start designing vehicles and road services that are considerate of the feelings of its potential users.

An interesting observation that this thesis ought to consider is how cultural differences are able to affect the flow of traffic and the effect it has on the drivers' emotions. Why is it than in different cities with similar road infrastructures there can be traffic in one and no traffic in the other, and in general, why can a driver go through different experiences depending on the city, or country he drives in.

The Importance of the Road as a Space for Interaction

The most common form of interaction on the roads is perhaps among drivers on the same street. The activity of coordinating car movements with other co-present drivers has been pinpointed as Traffic-encounter interactions [80], which consists on capturing others intentions through visible maneuvers and gestures as well as divulging your own to the nearby vehicles. Its three main components are the drivers, the vehicles and the streets where the vehicles are driven. Encounters between these entities are ruled by situated actions [109] and are of a brief and spontaneous nature. This type of social interaction reveals itself to be extremely complicated if studied cautiously. In particular, driving a vehicle on big cities can be proved to be extremely complex with high levels of meticulous details and including multiple instances of traffic-encounters. When a person

responds with a particular reaction to a particular event, the persons around him can dictate their next movements by a set of heuristics and schemas, which in turn affect the response from other individuals around them [1]. This form of intertwined interaction is what Ervin Goffman refers to as *performances* or "the activity of a given participant on a given occasion which serves to influence in any way any of the other participants" [33].

The social interactions occurring between drivers on the road, however, are of a special nature, since there is usually a lack of person-to-person communication. Instead, these types of interactions occur in *isolation*, in the sense that drivers are somewhat secluded from the world outside the vehicle, while at the same time they still interact with other drivers manipulating the vehicles around them. Researchers have acknowledged that "any driver is surrounded by several others and yet they may all feel lonely" [80], at the same time they foresee the potential benefits and enhancements on the driving experience that could emerge from providing road users with a way of engaging in social interaction. For this reason they have tried to create services and technologies that supplement for the lack of mediums in which drivers could communicate. Some examples of these can be seen in *User Interaction with Mobile Services in a Car Environment* [4], *Personal Interfaces-To-Go: Mobile Devices for Data Exchange and Interaction in Heterogeneous Visualization Environments* [113], *Tourism and mobile technology* [6], *Enhanced Social Interaction in Traffic* [28], *Traffic encounters - Drivers meeting face-to-face and peer-to-peer* [80], *Road Talk Informatics - Informatics for Local Collaboration Along the Roads* [54], *The Road Rager: making use of traffic encounters in a mobile multiplayer game* [7], *Sound Pryer: Adding Value to Traffic Encounters with Streaming Audio* [79], and other interesting works that explore the many different ways in which drivers can interact with one another. Relevant for this study is to observe the degree in which social interaction while driving is able to affect the drivers' moods. We could predict that a driver surrounded by few other experienced drivers rendering flawless actions would unconsciously feel content by his current environment, while a driver being victim of an accident would experience annoyance and anger towards the other driver. Also, Soundpryer [79], the prototype developed by the Interactive Institute Stockholm, can provide a good insight on the influence of social interaction on the emotions of the driver and his experience.

However, the question that often rises from the general public is how beneficial or necessary is the introduction of new technologies into an activity that seems to exist and work properly with any advanced equipment other than the vehicle itself.

2.3 Ubiquitous Computing for the Driving Experience

In the coming era of ubiquitous computing, individuals and societies in general might find themselves surrounded by different forms of interconnected technology that will hopefully improve the quality of life and work, and that will bring previously unheard of benefits to the enclosing communities. This emersion into the increasing and surrounding *invisible* technologies might inevitably occur even against the individuals' wishes or realizations. For this reason, it is crucial and practically essential to fully understand the routines, practices and behaviours of the intended users under their natural settings in order to develop technologies that fulfill their needs, wishes and requirements. The use of ethnography and other methods has been considered for the purpose of understanding users and their activities, and their findings have been used to inform the design of these new technologies. However, some individuals outside the fields of computing, design or technology oriented subjects, often wonder about the benefits and impacts that computers embedded into the environment might have on society. People usually also question the need of having new technologies introduced into their daily routines and often see no use on having strange devices that they might even not know how to handle and which are supposed to help them achieve

their tasks with more comfort and ease. Even participants of this study, whose responses will be later looked at in Chapters 5 to 8, and other people familiar with its intentions, but unfamiliar with the new paradigms of computer science, frequently speculated about the relationship of this study with the field of computing. It is the job of interested researchers and industries concerned with the design of new interactive systems to foresee the purposes and advantages of having constant access to information while on the road, and to communicate this purposes to its users and the general public through the use of design concepts and working prototypes that show the good intentions of technology developed for the road.

Augmenting the roads and vehicles with networked technology has multiple purposes and possible advantages. Not only can computers allow road users to engage in activities related to their work, but also they can make their driving experience more secure, interesting, attractive and emotionally appealing. The increasing number of vehicles on the streets and the considerable amount of time people spend on the road make a good excuse and motive to look into the development of technological devices and services that could make their time on the road more efficient and satisfactory. In particular, technology on the road can be used to exploit the indefinite continuous opportunities of engaging in some form of interaction with others, as remarked by Mattias Esbjörnsson [28] and Mattias Östergren, but also to make the road user aware of his own road experience and the ample set of emotions that can be affected and displayed on the road and by the road. Optimally technology of the road would provide its users with the richest of experience by raising their feelings up from their subconscious, by making them intentionally *feel* their experienced emotions, and by taking advantage of the multiple aspects of the road that have the potential of provoking sensations of well-being. It is important, however, that technologies to be introduced on a road environment are indeed ubiquitous and unobtrusive, following the guidelines for calm technology firstly proposed by Mark Weiser [119]. In fact, some of the projects mentioned above in the previous section are good examples of the initiative of designing technologies for mobility on the roads, which are hopefully just the beginning of what promises to be an interesting and prosperous area of study.

Toyota/Sony's POD vehicle, for instance, presents a revolutionary way of thinking about the way road users currently employ the road, and serves as a good example of how Weiser's vision of invisible, interconnected computational devices embedded into the environment can slowly perpetrate into society. The POD in itself could be seen as piece of machinery made out of several computational devices, different types of sensors, networks and other artefacts capable of performing some kind of operation. The regular user, however, is indifferent to the actual electrical apparatuses of the car and the way they function, but is mostly concerned with having a joyful and save ride, which the POD augments by presenting him, and the drivers around him, with certain kinds of information. The technological devices embedded in the car and the connectivity between them, however complex, become invisible to the user. These devices are programmed to receive or perceive important input from the external environment and transform it into relevant information that is externalized to the user in an appropriate way. An essential component to attain this seamless process of information and background computations, characteristic of ubiquitous computing, is the networking of various devices which connected can have the power of extracting relevant information from the surrounding environment. For the activity of driving, the environment or context is constructed by the vehicle as much as by the road, which means that the road infrastructure would need to be further developed in order to provide relevant ubiquitous computing services for the driving experience.

In the not too distant future, many cities might enjoy the benefit of constant broadband wireless access to the internet, which is a step forward in the direction of ubiquitous computing societies. The POD, for example, takes advantage of this possibility and downloads relevant material from the internet depending on the user's preferences. A vehicle that can connect wirelessly to the internet and to other devices located along the road might become a powerful tool that could serve

many purposes besides displacement or translocation. As a matter of fact, ubiquitous computing ideas have already been explored under a road context, in what is called *Ubiquitous Automobile Network Systems* [57]. These type of ubiquitous systems range from providing the driver with a information and entertainment to notifying road authorities when maintenance of the road is needed. Overall, this initiatives aim at providing the driver with a better and safer experience by offering services based on the individual attributes of the driver. But to know the individual attributes of the driver, we must first study them or have methods in which technology can accumulate this knowledge about the driver's attributes, and this thesis is intended to contribute in this area. By studying the emotional states of drivers and their experience in relation to their feelings, we plan to get a general set of requirements and wishes that can make for a better driving experience, and which can be supported with the help of technology.

The challenge still remains of convincing the general public that, although some technologies are neither essential for the existence of roads nor for engaging in the activity of driving, they will eventually create a safer and more reliable road environment as well as a more efficient and pleasant driving experience, to the point that drivers will need and make daily use of those technologies. Examples of making the road saver with the use of technology include the use of proximity sensors embedded in the car's exterior, preempting warning signals of accidents or traffic jams encountered further down the road, provision of information on the physical status of the road, weather conditions, etc. Some examples of technology that could make driving more efficient and enjoyable are some kind of device that alerts the driver of traffic levels in certain streets, dynamically advice on the optimal route to take to a destination, information on other drivers that would encourage social interaction, local information about the streets that might be unknown to the driver, and much more. In fact, roads are not being augmented with technology with the same rapidity that vehicles are becoming more modern, which gives more motives to study the actions happening under the context of the road, in order to support these actions and their context with technology, taking advantage of the potentials that the interconnectivity between road objects and the vehicle could bring.

2.3.1 Theories on Context

When designing for ubiquitous computing or other interactive technology, the concept of *context* becomes an essential subject that must be addressed, since it entails the environment in which activity unfolds. Different theories and perspectives have been used to capture the contexts of users and their actions while interacting with their environment or a specific design of a product, in this case, the contexts can be seen as the road. Lucy Suchman [109] and Paul Dourish [27] are two influential academics related to the theoretical aspects on the social discipline of understanding contexts of use, and the following sections present the theoretical frameworks relevant for the studies of ubiquitous computing, somewhat deviating from the actual topic of the emotional experience of drivers.

Situated Actions

Lucy Suchman, in her book of *Plans and Situated Actions* [109], presented some pioneering ideas on the notions of human activity and its situations which revolutionized some of the theoretical foundations for the field of Human Computer Interaction. She provided a new view on the way humans go about performing their common activities. In her opinion, every course of action is dependent on the environment in which it is performed, as well as the objects located under that environment and the social circumstances around it. Suchman suggested studying the way people

resourcefully use their circumstances in their environment in order to follow what they believe is the best action to take. Humans in general rely on subconscious plans to achieve certain goals; those plans, however, might deviate from its originality and be adjusted according to the presented circumstances along their course of action. Plans, in other words, are never definitive, but rather dependent on particular situations and circumstances. Suchman exemplifies this concept with an scenario consisting of rafting down a river with a canoe, where its occupants create a mental plan of what actions to take while maneuvering the canoe; the real actions, however, are rarely the ones previously planned but rather the responses to particular sudden situations presented by the immediate environment and dependent on one's own acquired embodied skills [109]. This model could fit, and be very representative, in the context of the road and its surroundings. Drivers usually follow regular routes towards their final destinations and at the same time they explicitly plan the path to be taken to an unknown place. What drivers are not capable of planning, but perhaps able to anticipate and influence, are the actions of their fellow drivers encountered along their journey, as well as the effects that the events occurring on the road will have on their emotions. Events in this kind of environments are ever-changing, moment-to-moment unplanned reactions to the surrounding actions of others. Other researchers, supporters of Suchman's situationist approach, identify as the unit of analysis for activities to be neither in the individual nor in the surrounding environment solely, but rather the relations occurring between the two. A *setting* implies "a relation between action persons and the arenas in relation with which they act" [72], where the *arena refers* to "a stable institutional framework" [72], such as the roads and streets. Situated actions theories stress the fact that situations do not span through time and they are not durable, but mostly temporary improvised responses to the immediate environment. This approach is, in a way, a reaction against some principles of artificial intelligence, which emphasized its problem solving approaches as a series of tasks to be accomplished based on specified rational solutions that lead to a probable overall result, but disregarded the context in which such tasks were solved as well as the flexible and opportunistic behaviour, characteristic of human activity, and more importantly, the set of feelings and emotions embodied by the individual performing the tasks.

Phenomenology

Phenomenology is basically a philosophical stance which recognizes the detachment of the sciences from practical human concerns. Therefore, its goal is to reroute scientific practices in order to provide more practical applications, useful for the real world. Phenomenology, as proposed by Edmund Husserl, tries to capture the essence of experiences by looking intuitively at phenomena around us, aiming at exploring the way humans experience their context. It is also concerned with defining *meaning*, arguing that we act upon a world filled with it, "the world has a meaning in how it is physically organized in relationship to our physical abilities, and in how it reflects a history of social practice" [26]. Dourish is perhaps one of the most influential advocates of the role of context in the design of new technologies from a phenomenological perspective. In several of his articles he recognizes the importance of context and proposes concepts and models that might lead to a better understanding of what context actually represents. In his book *Where the action is: The foundations of embodied interaction* [27], Paul Dourish provides an extensive set of terminology, measures and guidelines to be followed in the course of designing new ways of interacting with new technology by exploring the concepts of embodied interactions. His approach is intensely social, concerned mainly with how people act upon the world and the relevance of the situations and different contexts in which these actions take place. By understanding that technology and social actions can interact in different situations, it is possible to understand how the design of technology and the features of everyday social action are actually related.

Dourish also regards as important for the field of HCI the concept of *intersubjectivity*, or the ability of two distinct individuals, who experience the world in different ways and are owners

of their own private thoughts and emotions, to understand the meaning of one another's experiences. Intersubjectivity is an important processes in which individuals subconsciously engage in the course of their continuous, perhaps unintended, interaction. This leads to the ideas of *abstraction* and *accountability*, which are very relevant to the discussion of context and mentioned by Dourish in several occasions. The concept of accountability has two different aspects to it; the first basically refers to the shared understandings of the "observable and reportable" actions among people under a certain context; in other words, people understanding your actions while you understand theirs, and everyone being aware that their actions are being shared and understood. The second aspect entailed by this concept describes the relatedness between social action and accountability, arguing that they are inseparable and an embedded feature of activity that describes the bases for action and interaction. What is important is that "the analytic concept of accountability emphasizes that the organization of action, as it arises in situ, provides others with the means to understand what it is and how to respond in a mutually constructed sequence of action" [27].

Abstraction, on the other hand, implies our ability to comprehend the world without the need of constant explanation for it. Some research publications remark on the importance of the fact that developers of context-aware technologies should be familiar with these concepts and take them into consideration when designing for ubiquitous and collaborative interaction. Dourish also relies on the concept of *technomethodology*, derived from ethnomethodology, which is the use of sociological methods to study and understand work practices (but not processes) of individuals within a society. Ethnomethodology goes beyond than simple observational ethnography and concentrates on the efforts of the researcher to engage himself in the activities of others, and performing them as to become one of them in order to understand their commonsense behind the rationale of their everyday behaviour. By performing ethnomethodological studies the researcher might be able to have a better perception of the context of the particular situations in which those certain users are operating; in this way, context can become, in some sense, articulated and explained. Successively, technomethodology takes the fundamental principles of ethnomethodology to apply them in the general design of interactive systems.

Cognitivism

"Distributed cognition is a branch of cognitive science that proposes that human knowledge and cognition are not confined to the individual. Instead, it is distributed by placing memories, facts, or knowledge on the objects, individuals, and tools in our environment." [120]. This definition of distributed cognition implies the tied relationship between the cognitive processes embodied in the individual and the external artifacts positioned in the locale, therefore suggesting the essentiality of context or the individual's environment. The distributed cognition approach argues that knowledge and its representations exist not only within the individual but is embedded in the world's artifacts. Knowledge is propagated and transformed at the time of interaction between and within individuals and artifacts, which are constantly carrying information. In short, cognitive processes do not only occur inside an individual's head, but also in the interaction with the artifacts. This approach deals with what researchers referred to as structures, or the external and internal representations, and the transformations of such, due to interactivity.

Hollands and Hutchins [40], well known scholars for their contributions on cognition applied to the design of interactive systems, have suggested a framework which combines different activities and properties, such as performing ethnographic observations and controlled experimentations, as well as the use of work materials and the consideration of collaborative workplaces. By proposing ethnographic analysis, the researchers allude to the importance of the context in which work is taking place. Moreover, they present examples, such as ship navigation and airline cock-

pit automation, trying to show the properties of human's memory as a context dependent concept, which involves the interaction and manipulation of external artifacts and the internal cognitive processes involved.

In contrast with the situationist approach, which suggests the improvisatory, responsive actions to given situations, distributed cognition recognizes the human motives or methodological steps to accomplish desired goals. Distributed cognition recognizes the properties of objects as been endowed with knowledge and hence carrying information, whereas situated action theories disregard the possibility of external objects carrying certain properties or, in fact, discard these objects completely, arguing that objects and plans are created *a posteriori* from the reasoning of action, and that "goals and plans cannot even be realized until after the activity has taken place, at which time they become constructed rationalizations for activity that is wholly created in the crucible of a particular situation" [72].

Having looked at some previous studies that examined the environment of the road and having stated the meaning of the *road* and a *road user* and their relevance for the design of future technologies, it is now necessary to explore the complex concept of emotions and find a practical way to study them, issues which will be discussed in the following chapter.

Chapter 3

Emotions and the Driving Experience

So far this thesis has presented its main objectives and stated hypotheses, and has walk towards its goal by presenting some background research work and other concepts in the search for the constituents of the road and the possible technology that could be implemented on it. The next step is to agree on a definition of emotion, since its discussion is central for attaining the stated objectives, although the concept of emotion and the ways to capture those emotions embedded within each individual presents a challenge in itself, given that they are even sometimes difficult for the person to express and for others to recognize.

In an ideal world researchers would have invented a machine capable of reading human thoughts and explicitly outputting the feelings and sentiments of a person. In this way we would know with high levels of certainty the inner most wishes and desires of a user of a product. We would be able to design systems that match exactly the user's needs and requirements, and that will ultimately provide him with the richest of experiences, since everything that the user wants the system might provide. Besides offering utility and usability to the user of a system, designers of new technology could also bestow pleasure, excitement, arousal and other wide range of emotions that make everyday life complete on the user [36].

Unfortunately such machine does not exist and it is far from being invented. On the contrary, the challenge of capturing the user's experience is a cumbersome and risky one. In recent years the field of computing has been concerned with designing interfaces that are appealing for the user, since the satisfaction of the user might bring a better quality of work, more economical rewards and an enhancement in everyday routine practices. The field of affective computing studies the ways in which a "computer will be able to recognize human emotion and the computer will respond to it" [36], it is, as Picard defines it, "computing that relates to, arises from or deliberately influences emotions" [84]. Basically, affective computing tries to recognize the essence of human emotion and affection and transform it into bits and bites. However, it might not be sufficient for an ubiquitous system to simply recognize what the user is emotionally feeling and try to output its findings, since what we are aiming for is at enhancing the user experience in a way that users emotions are affected and not only documented. Similar research aimed to find emotional characteristics on the road has tried to detect the physical expressions of emotions by using sensors that capture corporal reactions to stimuli [29]. The researchers try to measure factors such as heart rate, facial expression, breathing patterns, oxygen concentrations, sitting posture, eye movement, etc. in order to determine the driver's current emotional state but, not only it is not possible to capture all sets of emotions through physiological responses [104], "instead of sensing and transmitting emotion, systems should support human users in understanding, interpreting and experiencing emotion in its full complexity and ambiguity" [5]. Nevertheless, in the task of supporting users to

understand, experience and enhance their emotions designers of technology should have a clear conception of what emotions are all about.

For decades psychologist, philosophers and other researchers have discuss the actual meaning of emotions without reaching a clear agreement on its definition [104]. The truth is that the concept of *emotion* and all that it entails are complex and mysterious themes to study, difficult to discern in their indivisibility and harder yet to convey a real understanding of their true meaning to others. To deeply engage into a profound conversation of the definition of emotion can result in more of a philosophical rather than practical discussion, and therefore a lengthy presumptuous debate of what emotions constitute is out of the scope of this thesis. However, any paper that attempts to tackle the topic of emotions scientifically ought to agree on the bases of its definition, hence the following sections will try to expound on the concept of emotions and personal experiences, and the differences or similarities in terminology, which will later serve to build upon the discussion of this thesis.

3.1 On Emotions and Personal Experiences

Currently we categorize and understand emotions with words, so that if we speak of anger or happiness we can have a clear mental picture of someone embodying those emotions. It is not difficult to imagine an angry dad, a sad old lady or a happy child. However, those words are just labels readable by everyone and culturally understood, but which might not cover the whole range of emotions which humans, or drivers for that matter, are actually capable of experiencing. Analogically to colors [89, 107] (see Figure 3.1), where *white* and *black* can be considered the extremes of a wide set of colors that present themselves in a blending continuum in which humans have labeled only those colors that visually differ from each other but inadvertently disregard those that are found in between labeled colors, so could emotions exist in a continuous range from *happiness* to *sadness* with a variety of emotions in between each with varying degrees of intensity. Some of these 'in-between' emotions are easily recognized and expressed, like joy, anger, annoyance or calmness, but some other emotions individuals have trouble identifying even when they are the owners of their emotional states. It is not easy to express the feeling that lies between a state of happiness and that of excitement, which are closely related but might not be the same. By the same token, emotions might present themselves in a two-dimensional axis where the same emotion can consists of different levels or intensities [98]. We do not feel the same level of fear in the presence of a spider to the fear felt on a life threatening situation, neither are our reactions to those events the same; in one we might gasp, scream shortly and eventually get rid of or get away from the spider, while in the other we would perhaps cry, yell frantically and beg for help to arrive, nevertheless the labeled emotion for both cases would most likely still be *fear*.

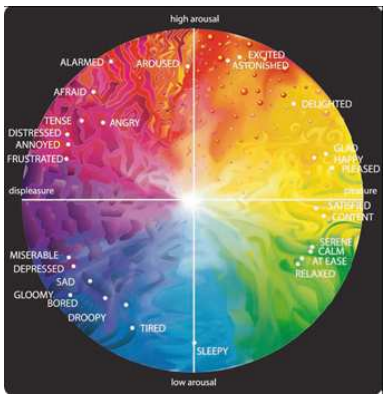


Figure 3.1: The circumplex model of affection represented with colors and shapes. Taken from P. Fagerberg, A Ståhl and K. Höök, *eMoto: emotionally engaging interaction*, [107].

Subjectivity is another known characteristic of emotions [22, 56]. Emotions are individual experiences which cannot be felt in their purity by anyone else but the person experiencing it.

Even in the same situation under the same environment two different persons might yet undergo different emotional experiences, depending on many factors or variables which combined can form an emotional state that is, in a way, unique and different from the state of surrounding others. In a road environment, for example, the way in which a road user experiences the road might be different from the experience of another user moving through the same road at the same time, similar to the way different spectators are emotionally impacted by the same movie in different ways and pay attention to some details more than others. People differences in personalities and previous past experiences can account partially for this individuality of emotional perception. A person might feel happy and excited to go for a day to the beach while other person might feel gloomy or nostalgic because that same beach brings him back memories of an ex-girlfriend which whom he used to visit that beach frequently.

This introduces the relationship between memory and emotions, which is another important aspect of the study of emotions. Substantial research has been made on the impact that strong emotions have in the recollection of previous events [92], but research has also shown the importance of the influence of past memories on current emotions [25]. Recollections of important places, loved persons, cherished objects, dear pets, precious moments, traumatic accidents, disturbing images or upsetting previous situations can elicit feelings of joy, nostalgia, love, happiness, sadness, arousal, anger, content, tension, etc. Looking at a picture, which is a physical object, can bring back emotions related to its image and the moment it was taken. Similarly, the road is filled with physical entities; as a driver displaces himself through the streets of a city, he might encounter informational objects that trigger the recollection of past events and eventually affect emotions. For example, driving through the neighborhood where the driver used to live as a child can bring happy memories of his childhood, thus provoking a momentary happy filling. To recognize that emotions can be a product of evoked memories as well as of external objects implies that emotions can be generated and influenced by the contexts and immediate environments in which a person acts [34, 55]. It is then a mixture of internal (memories) and external (physical objects) entities which can provoke intriguing emotions within the self.

Experiences

From its formal definition, an *experience* can be described as the "knowledge of or skill in or observation of some thing or some event gained through involvement in or exposure to that thing or event" [122], which differs from the concept of emotion. In very general terms, it could be argued that the difference between the terms *experience* and *emotion* is that experiences are *lived* while emotions are *felt*. From the point of view of the field of Human-Computer Interaction, Interaction Design or Experience Design, the User Experience, usually abbreviated UX, implies the quality of the interaction of a user with a specific design of a product or system [58]. The experience of an individual while interacting with a product can be created, in part, by a wide variety of emotions, but also an experience can in turn provoke emotions in an individual, i.e. emotions are *experienced*, in the sense that they are elicited from the engagement on an activity or the exposure to an event, but emotions also form part of an experience.

Moreover, the presence of negative emotions does not necessarily represent a negative experience. One can display emotions of fury and intense fear which, even when they are thought to be unpleasant, they make the person actually *feel* something, perhaps rising him above his normal emotional states or moods and, in some sense, making him feel *alive*; it comes as no surprise that some people enjoy watching horror movies, even when fear is not categorized as a pleasant emotion. A speeding driver, for example, can have the mixed sensation of momentary excitement and fear, which overall leaves him with what he might consider a positive driving experience. In this sense, it is not the polarity of the emotions but rather the intensities with which such emotions

are felt that constitute the driving experience.

For the purpose of this discussion, the remaining of this thesis will generally refer to the term *driving experience* as the set of emotions felt by a person while engaging on the activity of driving, which are provoked by the many factors encountered on the road along the driver's journey and are also able to alter some of those factors due to the cognitive and behavioural consequences caused and displayed by the driver.

It might be possible to speculate for many more pages on what experiences and emotions are and what they are not, how they are formed and how they are structured, without arriving to any concrete conclusion or providing any substantial scientific evidence to prove those claims. In the academia, the topic of emotions has been tackle from a evolutionary perspective [86], a physiological perspective [49, 84], a neurological perspective [9, 25, 66], a psychological perspective [30, 98], a sociological perspective [50, 56, 70], and perhaps many other perspectives; but as previously mentioned, the study of emotion is a vague and confused field, in which the only thing researchers have agreed on is that its definition is not at all clear [94]. For the purpose of this thesis we will try to work with the concept of emotion from a practical and simple point of view, partly taking a psychological stance and mainly following, but not limiting to, professors James Russell's and Larsen's frameworks on core-affect and the construction of emotions [98].

3.2 Choosing A Model for Interpreting Driving Emotional States

Over the years several models have been proposed by researchers as possible methods to capture and understand people's emotions while interacting with some objects or performing an activity. Examples of such models include the *OCC Model* (which acronym stands for its authors initials, Ortony, Clore and Collins) [78], or models proposed by Roseman [105], N. Fridja [31], and Watson and Tellegen [118]. The OCC model, for example, has been used in numerous studies that explore the effect of computers on emotions.

James A. Russell is one of the many scientists who have proposed an explanation for the understanding of emotions. He has published several articles concerned with the construct of emotion and what he defines as *Core Affect*. As summarized by Russell himself,

> Core affect is the neurophysiological state consciously accessible as simply feeling good or bad, energized or enervated. A circumplex model of core affect provides a good fit to data on mood, affective reactions to places, and the emotional interpretation of faces; provides a means of integrating various models of mood; and summarizes results obtained with two-year olds and those speaking various languages. One specific focus has been the question of whether feeling good is, as assumed in the circumplex, the bipolar opposite of feeling bad – or whether these are better thought of as separable or even independent responses [97].

In other words, core affect refers to the elementary emotions that people are able to consciously experience and have access to at any given moment. Russell's research has consistently shown that emotional states can be described in terms of two bi-polar dimensions [64,98], combining the variables of *arousal* in one axis and *valence* in the other. The two extremes of the arousal

axis consist of activation and deactivation variables, while the valence axis has unpleasantness and pleasantness as its opposites. As seen in Figure 3.2 an activation state could include the feelings of tension or arousal, while sleepiness and fatigue are closer to the deactivation state; happiness could be seen as a pleasant condition, whereas sadness or anger could fit within unpleasantness.

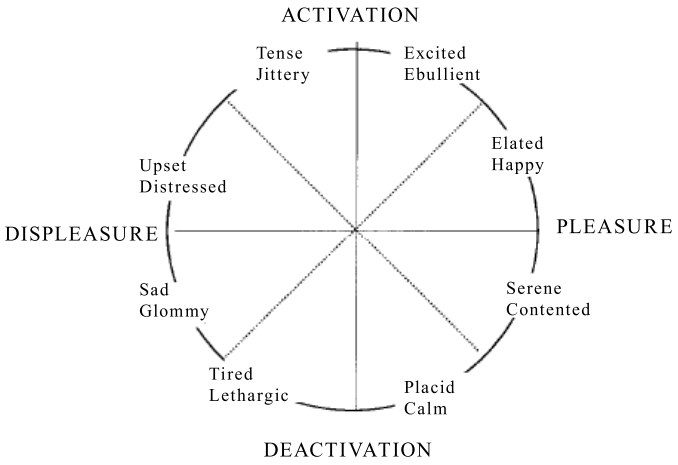


Figure 3.2: Circumplex. Taken from J.A. Russell, *Core Affect and the Psychological Construction of Emotion*, [98].

This model also accounts for the intensity of an emotion and can be described by positioning core affect within one single point of the circumplex with respect to the axes' intersection. The closer the emotion is to the intersection the weaker it is experienced, but regardless of the intensity Russell claims that core affect is always present within an individual. "Core affect can be neutral (the center point), moderate, or extreme (the periphery). Changes can be short lived or long lasting (as in a clinical depression). Intense core affect can be the focus of consciousness, but milder core affect is typically a part of the background of the person's conscious world" [98].

Russell confirms the possibility that emotions, or core affect, could be provoked by external causes, to be later internalized and processed cognitively by an individual. However, there are many instances when an individual is filled with emotions for no particular reason, or rather, for a reason that they might not understand or be consciously aware of. Their emotional state can be "manipulated by drugs: stimulants, depressants, euphoriants, and dysphoriants" [98], which supports the idea that some form of emotion could be rooted in biological or neurological factors.

His research on the topic of emotions and his proposed circumplex model of core affect or two-dimensional framework appears to have gain popularity and acceptance, and it has been used as the bases for many studies that try to deal with the emotions of users in different fields, such as experimental psychology, sociology, affective computing, interaction design, marketing, politics, to mention a few. Examples of the applied use of Russell's framework can be found in [45], [34], [59], [105], [107], [94] and many more. However, his propositions have been debated, and it is understandable that they might be far from perfect since any researcher trying to explore this topic might encounter serious obstacles and detours.

His earlier work was criticized arguing that the results obtained from the study and the foundations of his framework were dependent on the choice of words to describe emotions, the number of words assessed and the applied methodologies, implying that they are culturally biased or somewhat incomplete [95]. Critics state that the two-dimensional circular shape found by Russell and other scientists is dependent of the descriptors of physical states, such as the words sleepy,

drowsy, aroused or active [101], and advocate towards grouping or categorizing descriptors according to their similarity. When such adjectives of physical states are removed the circumplex looses its shape and flattens out [94]. Other studies revealed the possibility of feeling two mutually exclusive feelings at the same time [63], since the circumplex model suggests that happiness and sadness are polar opposites and therefore can never be experienced simultaneously, yet people have reported having a sensation of both happiness and sadness after watching the Italian movie *Life is Beautiful*.

Despite of its few critics, Russell's circumplex model of emotions was chosen over the models proposed by Ortony, Roseman, Scherer, and Fridja for the simplicity it presented compared to those other models [105]. It is anticipated that Russell's model will provide with an easier way of categorizing and mapping the various emotions expressed by the participants of the future experiments. This model, unlike the OCC model, is also simple enough to understand, interpret and explain, and it can be easily adapted or modified, if needed, to the corresponding requirements of a particular study, in this case the study of drivers' emotions on the road. This thesis will use Russell's model as a departure point towards describing emotional states; in other words, the initial wording for describing emotional states will be taken from this model, but will be modified according to the initial observations of the actual emotions, or expression of emotions by the drivers participating in the studies (described further in this thesis). For example, in one of the articles presenting the circumplex [99], Russell uses emotional adjectives such as *happy*, *fatigued*, *tense*, *relaxed*, etc. However, some of these words will not be used or some others will be added to this list of descriptors depending on what participants frequently manifested while driving and also some other words will be taken from Larsen's [64] and Russell's earlier studies [89], which include words such as *annoyed*, *frustrated*, *bored*, *sleepy*, states that a driver is likely to manifest.

Some words that have been considered by other researchers to describe emotions will not be taken into account here, rather they will be interpreted in rational ways; if a driver expresses his *love* for driving it would be sensible to label his pleasant emotion as *happiness*. Besides, expressions of love, hate and similar verbs entail a long lasting attitudes towards one thing, whilst this thesis is mostly searching for the momentary emotions felt at particular times and situated occasions. The phrase 'I *love* to drive' would suggest a pleasurable state while driving in general, however it can provide clues on the drivers current emotional status, depending perhaps in their tone of voice and body movements. A driver could spontaneously express 'I love to drive' with a smile on his face while traveling in a street without traffic under a sunny day, which can be a clear clue for an observer of the happy feelings the driver is containing at that particular moment and should be recorded accordingly. On the other hand, a driver could utter 'I love to drive' with a sarcastic tone of voice while being stopped in traffic feeling the tedious heat from the sun, which can be easily interpreted as a negative overall emotion. The researcher has the task of objectively interpreting these indirect exclamations and leave out the utterances that are too vague to interpret. For the sake of simplicity and for the purpose of obtaining a most robust set of results this thesis will be also inclined towards Larsen's circumplex model [64], whose work is heavily adopted from Russell's model and conveniently divides the circumplex into eight affective states: *High Activation*, *Activated Pleasant*, *Pleasant*, *Unactivated Pleasant*, *Low Activation*, *UnActivated UnPleasant*, *UnPleasant*, *Activated UnPleasant*, as seen in Figure 3.3, with each of these states containing groupings of emotions, which makes their classification more generalizable and the results more universal. In this way a driver's enthusiasm or joy for driving, for example, would fit the *Activated Pleasant* state instead of being associated to just one word or label.

Russell's and Larsen's models, however, will not provide a way of capturing those emotions, but rather they will serve as a preliminary taxonomy that will aid the initial steps to be taken towards exploring the emotionality of driving and will shape the form and choice of research methods to be later used in the challenge of capturing the emotions of drivers.

3.3 The Challenge of Capturing the User Experience

It is a well known fact within the field of design that what people say about their thoughts or feelings and what they are actually thinking or feeling is not always the same. This poses the first great challenge in almost any design task and for any study that attempts to capture the experience of users under natural settings. The use of traditional methods, such as interviews, questionnaires or traditional observations, which are frequently used by some researchers to capture the users' opinions, might not be sufficient or might even be inappropriate for getting a true understanding of the user experience on its pure form under some circumstances. Thus, there is a need to employ innovative methods that can complement or replace the conventionality of the older ones and yield better results depending on what the researcher is trying to achieve. In this case, the aim of the thesis is to capture the mystery behind the emotions of drivers while on the road, although comprehending the concept of *emotion* is a challenge in itself.

As mentioned previously, emotions are very personal and subjective, which makes them hard to interpret. Even though we as humans are quite good at recognizing the emotions of our close others, we still cannot be a hundred per cent sure of the particular emotion that is consuming them. Just by looking at the facial expression on others' faces or by listening to their tone of voice or by paying attention to their choice of words, we could tell with accurate certainty that they are feeling happy, sad, annoyed, angry, etc. Most times we can correctly judge our friends' *enjoyment* of our company when they laugh about some anecdotes, our parents' *excitement* and *content* by hugging us, nodding in approval and displaying a smile across their faces when we accomplish something important, or our boss' *anger* when he yells at our lateness and the sloppiness of our presented work. Nevertheless, the mystery of emotional display presents itself when we are witnesses of, for example, a mother crying tears of joy, or a football couch frantically yelling to his players for doing a great job at winning, or perhaps a dad sarcastically grinning at his son in disappointment, since we tend to mentally associate tears with *sadness*, yelling with *anger*, and smiling with *happiness*. Moreover humans are good at hiding their true emotions [42] and even outwardly portraying false ones if they so desire to. A person trying to study the emotional state of others might be very well deceived by the mere external display of those emotions, such that it he observes a person laughing he might assume he is consumed with some form of happiness, which might not be true in all situations.

Some other times emotions are misinterpreted or hardly displayed by an individual in an obvious manner, like when a person can be feeling fulfilling happiness and yet do not show any facial changes or extravagant body movements, which makes the task of computer systems that attempt to capture human emotions a difficult one and which generates results that cannot be hundred percent reliable [20, 42].

In fact, many people do not know how to accurately express their own emotional state at some given moments [85], even when we are continuously experiencing some kind of emotion. This fact makes the researcher's task of finding individuals' emotions an even more complicated one. How can a researcher know the feelings of the participants of a study when it is hard for the participants themselves to know how they feel? Moreover, how can a researcher who tries to study emotions know what to look for when the concept of *emotion* in itself is still unclear to experts on the field. Not even scientists who have dedicated most of their academic career in the search for a meaning of emotion can explain the term concisely neither can they agree between them on its concrete definition. This is perhaps one of the biggest challenges of this thesis and of any other research work which operates with the concept of emotion and is therefore based, in a way, on unstable grounds. Trying to study people's emotions without knowing with complete certainty what emotions are is like walking blindfolded through a labyrinth. The reader should be aware that the results presented on this thesis are somewhat dependent on the propositions of

other researchers, such as Russell, who study the concept of emotions and offer frameworks to study and understand them, but which might not be completely accurate.

Regardless of their precision, they provide fair grounds on their conception and have previously allowed the development of efficient prototypes in the course of designing technological artifacts that have the purpose of supporting and enhancing the user experience.

3.4 Importance of People's Experiences When Designing for Technology

The experiences of users are rich, varied and unpredictable, and new technologies are supposed to support and possibly enhance these experiences on their natural contexts without disrupting the actual course of their actions. For a number of years now, designers of computerized systems and programs have realized the need of studying the potential users of a system before engaging in the actual process of product development. The field of computing is not the only one concerned with the experience of its user for the design and development of its products, in fact, the fields of marketing, branding, architecture and industrial design are just some of other disciplines that are concerned with studying their users or customers in detail in order to provide them with products that fulfill their needs, wishes, requirements, conveniences, logic, physical capabilities, and more.

The automotive industry is a good example of a business which tries to design products that are appealing for the emotions and identities of their buyers [21]. Vehicle manufactures are well aware of the diversity on taste and experiences of their customers and consequently build cars that attract their buyers' various interests in terms of the engine power, external looks or auto bodywork, interior design, size, stability, comfort, etc. However, a car, despite its varieties in looks and makes, serves mainly one purpose, that of transporting its passengers from their departure point to their destination. Besides its practical purposes, the choice of use of certain artifacts, in this case cars, is ruled by the context, the occasion, and above all, the mood of the individual [76]. But, how can the designer of things know the contexts, occasions and moods in which an individual might be while interacting with his designs?, which are factors that will ultimately influence and dictate the overall user experience. Hence, the meticulous study of users and their contexts, as well as their emotions, is very important in the process of design. In the case of designing for ubiquitous technologies the researcher has to be particularly observant of not only the activities of users and the contexts in which they unfold, but also it is essential to examine the possible interactions occurring under the user environment, which besides consisting of the interaction between users, also include the possible interaction of the users with the existing technologies, as well as the interactions between these technologies themselves.

Some approaches known to the design of interactive technological products use the methods involving *personas* [15] and *scenarios* [10] to inform their design processes. "A persona is an archetype of a user that is given a name and a face, and it is carefully described in terms of needs, goals and tasks" [100] while scenarios are detailed description of possible situations that the persona may undergo in relation to the product at hand. The descriptions of personas are usually based in the initial observations made by a design team during the pre-design phase, therefore projects that employ this methodology feel free to leave the examination of actual users out of the study for the remaining of the design process. Even though the use of personas and scenarios has been a popular methodology in the field of HCI, which has been used in multiple design projects, serving as a good communicational tool between the members of a design team, and which might provide favorable results in some occasions, it is clear that its use is not appropriate in all circumstances and for all design tasks. No matter how precise persona might be described

or how detailed a scenario might be depicted, the designers in charge of their creation are very unlikely to fully capture the richness that constitutes an actual potential user who unfolds in a variety of settings involving variables of space and time. In fact, an ethnographic study done *in* a design team showed how the members had difficulties conceptualizing a persona and that the method did not help them visualize the real end-user, forcing them to employ other techniques to involve the users and compensate for their problems [100]. This mentioned ethnographic study was done to the members of a design team of a real company which regarded the use of personas and scenarios as fundamental tools through their design processes and which, according to the authors, went bankrupt after their study was made [100]. Under a road environment, characterized by its multiple interactions, situated actions and richly detailed contexts, the sole use of personas and scenarios to develop appropriate systems for this environment would surely be bound to failure. For this reason, the actual study of the real, and not fictitious, daily occupants of the road is essential towards the understanding of their behaviours, routine practices and inner feelings, which, once understood, could serve as good cues and guidelines to inform the design of new technologies.

In the course of designing for technology that relates to emotions, designers also ought to consider that the individuals' emotions are closely related to their cognition, such that they affect the way the human mind functions intellectually [77]. "Positive emotions are critical to learning, curiosity and creative thought and today, research is turning toward this dimension" [77]. The sensation of being motivated, joyful or happy commonly relates to more efficiency and productivity at the tasks at hand, since it allows for better brainstorming and examination of multiple alternatives [77]. These observations have important implications in the ways to go about designing technology to support emotions on the road, and will be discussed further in Chapter 9.

As was previously mentioned throughout this Chapter, the concept of emotion is mysterious and intriguing. Researchers have struggle on finding proper ways of capturing and measuring those emotions contained and displayed by individuals. Perhaps the biggest difficulty comes from the vocabulary and choice of words that categorize emotions, although generally a person can have a broad understanding of the emotional states of others at particular points in time. Psychologist James A. Russell has proposed a framework for the study of emotions [98], which has been developed further by other scientists such as Larsen et al. [64] and which will help to categorize and analyze the emotions of drivers in some of the subsequent chapters of this thesis. Russell's model, however, does not provide methods for *capturing* those experienced emotions. Instead, those methods will be discussed and presented in the following chapter, Chapter 4.

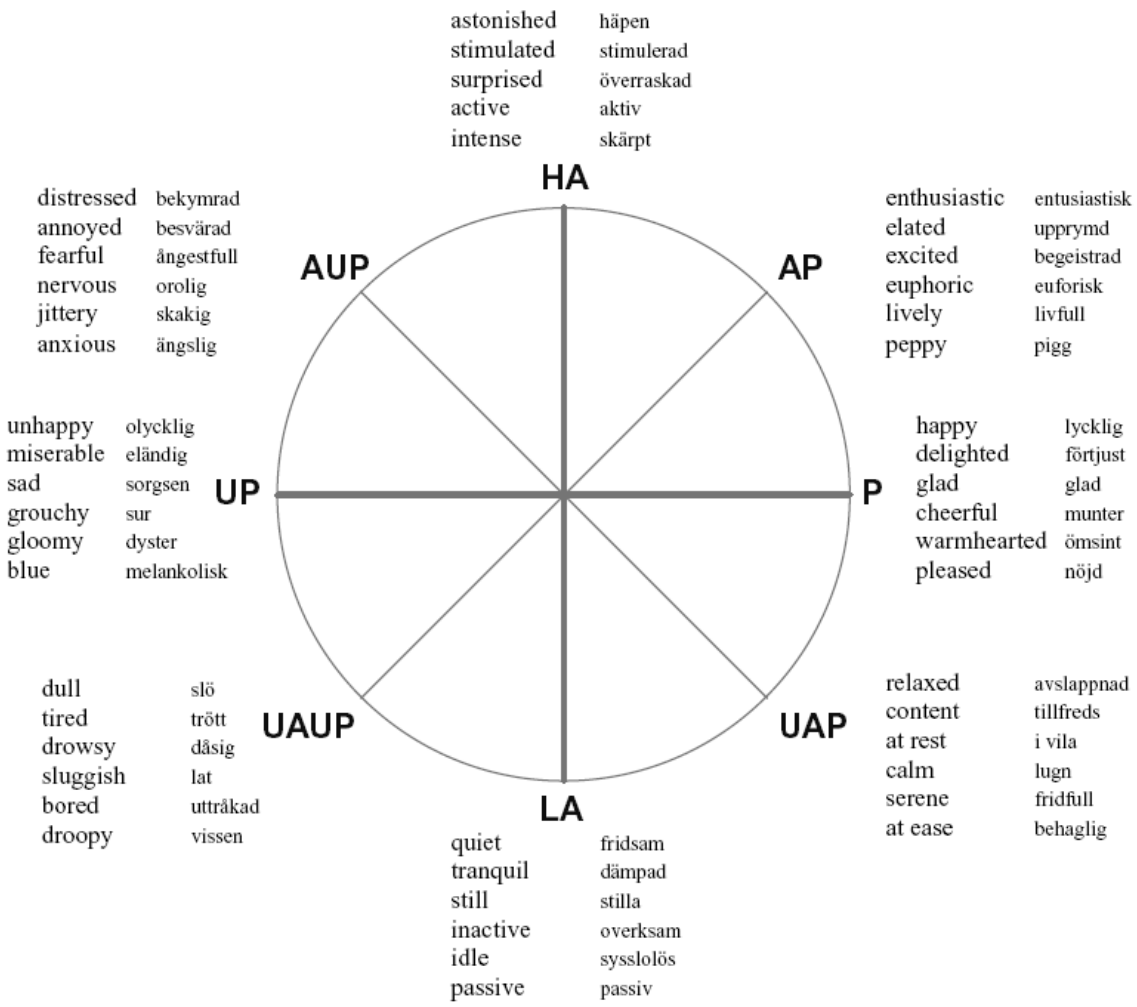


Figure 3.3: "The affect circumplex space, with eight affective states represented by forty-eight English adjectives (Larsen & Diener, 1992 [64]; adopted from Russell 1980; Watson & Tellegen, 1985) and the corresponding Swedish adjectives. *Note*: HA = High Activation; AP = Activated Pleasant; P = Pleasant; UAP = Unactivated Pleasant; LA = Low Activation; UAUP = UnActivated UnPleasant; UP = UnPleasant; AUP = Activated UnPleasant." Taken from I. Knez and S. Hygge, *The circumplex structure of affect: A Swedish version*, [61].

Chapter 4

Research Methods and Experiments

As mentioned in the previous chapter, the task of capturing the user experience under some circumstances is not an easy task, since this experience can be very personal, very unpredictable, easily altered and not easy to communicate to others. Furthermore, natural experiences take place outside laboratory settings in a rich and variable environment that is, most likely, under constant change and where spontaneous, unpredictable and situated actions are always taking place. This is one of the reasons for which ordinary interviews and questionnaires are insufficient methods to gather consistent data on genuine user experiences. Another reason is that the subjects answering questionnaires or interviews have to make use of their retrospective memory, reflecting upon their previous actions and recalling mostly what was most relevant of a situation or the most recently occurred events, what psychologist call *priming*. The richness of the situation and practical details of the surroundings tend to be left out by the respondent of ordinary interviews or answerers of questionnaires, since this unremarkable information is commonly forgotten or filtered out by the brain [55]. Moreover, individuals perform most of their daily activities in a routinary fashion, which allows them to carry out their actions unconsciously without having to stop and reflect on what they are actually doing. The act of driving can be seen as a daily routine for experienced drivers. They use their car as an artifact or a tool to get from one place to the other, and their driving activity is common in the sense that they might practice it almost everyday, but it is not always ordinary in the sense that they might encounter special circumstances along the way that might catch their attention and make them become conscious about their own actions and the actions of other drivers around them, and therefore of the overall flow of traffic. In the routinary activity of driving, the individual unconsciously follows a series of steps to accomplish the common tasks of opening the vehicle's door, sitting down, starting the vehicle's engine, pressing the clutch while changing gear and at the same time push the accelerator, visually locate other vehicles and maneuver the steering wheel, etc. All these actions, some of which are performed simultaneously, and the emotions contained by the person while doing them are probably passed unnoticed most of the time; thus, simple questionnaires or interviews that ask the experienced driver to provide an account of his emotions while performing those tasks based on previous recollection of events will be flawed and terribly biased towards the remarkable and the extra-ordinary. This is not to say that interviews and questionnaires are completely useless, since they can be used as alternative resources or as confirmation of the results obtained from former approaches.

To understand the act of driving, and in particular the emotions of a driver, more elaborate methods can, and should, complement the use of interviews, questionnaires or simple video recordings. These other methods ought to consider the situatedness of the experience, and capture the driver's emotional states as it unfolds and is modified by the external immediate environment. These methods should also consider the routinary nature of the activity of driving and take into ac-

count the incompleteness on the uttered responses of drivers to specific questions, but they rather should look at the meaning behind those responses as well as the cues and details of the different actions, behaviours, intentions and interactions.

The following sections present some methods commonly used in the fields of interaction design, CSCW, sociology and social psychology in the hopes of capturing the user's experience. The purpose of this thesis is to present and employ these methods for their later evaluation, trying to discern which would yield better and purer results towards understanding the emotionality of drivers and the factors that create or transform those contained emotions. The choice of methods was motivated by the available literature and suggestions from experienced professors in the fields of the sociology of technology (Oskar Juhlin) and human-computer and work (Marcus Sanchez Svensson), but was limited by the technology at hand and the time allowed to gather data. Namely, these methods include the use of *Cultural* or *Urban Probes*, *Ethnography* and the *Experience Sampling Method*, complemented with interviews and discussions on the road. It is hypothesized that the best of results would be obtained not from a single method, but from a combination of the methods used, such that the mixed analysis of the data gathered from these various methods would provide a more robust and truthful outcome, hence a better understanding of the reality of drivers' emotions.

4.1 Cultural/Urban/Technology Probes

The Cultural Probe methodology provides an alternative to conventional Human-Computer Interaction techniques in the process of designing new technologies. The concept of cultural probes was originated by Bill Gaver et al. [32] while trying to come up with technological solutions for elder communities in three different locations and cultures (Norway, The Netherlands and Italy). The unfamiliar characteristics of the studied groups and their difference in location created a challenge for the researchers who wanted to analyze the natural living patters of elderly people, understand their culture, discover their 'beliefs and desires' and gather the necessary requirements for the development of technologies to support their everyday activities. The designers wanted to find out the opinions and needs of the 'user groups' without indirectly imposing their own beliefs or influencing the responses of the subjects in any way. Their idea then was to provide the participants with a collection of objects, or *probes*, which they carefully planned beforehand with the intention of being understandable by the studied subjects and with the aim of obtaining high levels of response. The package of probes included around 10 Postcards with questions written on them, intended to be informal, casual and friendly modes of communication and different from ordinary questionnaires. The package also included Maps, in which participants were supposed to mark places as answers to some relevant questions, and disposable Cameras with written requests of the types of photos the participants should take. A photo Album and a Diary were also included as probes, in which participants were supposed to write their daily experiences of using television, radio and telephones. The subjects were supposed to fill in the probes whenever they pleased and post them to the researchers at their own convenience. Gaver et al. claim that participants responded positively to their approach and that they received plenty of answered material within short periods of time, especially from the Norwegian location, whereas the town in Italy sent back less than half the probes, which researchers interpreted as being an indication of the good way of life the elderly community in this Italian town has. Researchers state that the use of the probes aided them in their design process but were not the only factor that influenced their design decisions, it was rather their own observations and involvement on the studied sites that enabled them to come up with more design ideas.

Since the introduction of cultural probes into the design discipline some other researchers

have attempted to make use of similar procedures or apply the methodology for their own studies [17, 41, 81, 83, 124]. Eric Paulos and Tom Jenkins are two researchers who tried to bring the concept of cultural probes to the design of technologies for urban areas. They recognize that "it is difficult, but not impossible, with current research approaches to inspire radically different devices, interaction styles, and novel views of our city and its inhabitants" [82]. Hence they suggest the use of what they like to called *Urban Probes*, "a lightweight, provocative, inspirational research methodology for exploring computing in urban environments" [82], motivated by the previous research of Gaver [32] and Hutchinson et al. (technology probes) [47]. Paulos and Jenkins propose a series of steps to be followed by researchers interested in using probes as a way to find out their users' environment and designing for technology. First, the researcher should perform some *Body Storming*, analyzing the environment in extreme detail along with its people and the activities that on it unfold. Secondly, the investigator should directly intervene in the environment, altering it in such a way that the users become aware of its change and curious on the reason for its disruption. The third step consists on producing noticeable prototypes to be introduced into the users' environment, functional enough as to disambiguate its purpose and the environment itself. Lastly, a fully working device should be placed within the environment making careful observations about the users' reaction to the new artifact encouraging their interaction with it.

In short, probes are tools that allow the measurement of unknown factors [82] and the collection of data in a timely manner. The probe methodology allows the researcher to have a quick overview of people's daily activities without interrupting their routines and normal practices. Their intention is to provide researchers and designers with information about their intended users, making them participate in indirect ways that can appear enjoyable and innovative, thus returning fruitful data that can inspire its examiners with ideas on how to develop appropriate technologies that will fit the user group's needs and wishes, hence improving their experience overtime.

For this project, the intention is to capture people's emotional experience as they drive. In this case probes could be used to evaluate the unknown factors of emotions and the driving experience without interfering too much with the actual act of driving. If carefully planned they could return interesting and helpful results, which will provide a general idea of the drivers' emotions on the road. Designers recommend using probes in the early stages of a design project [106]. Although this thesis is not particularly concerned with the specific design of a product the advice was taken of studying the probe methodology as a first attempt for exploring the experience of drivers. The initial motivation for experimenting with the probe methodology came from the writings of Gaver, Paulos, Jenkins and others, and their reports of successful results, which inspired the use of lighter and modified versions of Probes, which are presented below. The following sections describe three kinds of Probes employed in this thesis work, as an early attempt to capture the drivers' opinion and experience. The three probes consists of *Postcards* with questions, a *Road Picture Gallery* with photographs taken by participants and their descriptions, and the examination of people's *Web logs* (such as blogs, videos, discussion forums, etc.).

4.1.1 Postcard technique

William Gaver and Eric Paulos used maps and postcards as their probing objects, asking participants to write on them their answers to some relevant questions. Initial ideas for this project were to provide drivers with a map asking them to draw the route they have taken as soon as they have arrived to their desired destination, pinpointing places along their path where they have felt some kind of emotion, either positive or negative and to write it down as a little side-note on the map itself describing what they have felt and the factors that created the emotion. For example, they could write down their feelings of stress experienced at a busy intersection, or their calming

sensation provoked by an adorned park along the road. However, this initial idea was discarded, given that retrospective recollection of events has to take place in the mind of the participants and memory. Experiences are very fluid and the memory of them can be influenced by other thoughts or experiences going on in the person's mind. Therefore, probes should try to capture experiences while they are actually taking place or serve as vivid reminders of such experience.

Another important aspect of using probes is to make them informal and somewhat personalized, so that the participants do not become aware that they are being examined or stressed by the intentions of performing well on the study and of providing good results for the researchers. Previous studies suggest that probes should be seen as casual objects, to be designed in a way that participants feel comfortable with them, therefore allowing them to answer the included questions in a friendly, easy manner [32]. With this in mind, elements of informality were added to the probes designed for this study.

Procedure

Copying Gaver's approach, similar, but simpler and fewer probes were developed and distributed among few friends and some strangers. These probes consisted of a map of the city and a postcard with a written question. All of these were enclosed within an envelope which had a glued prepaid stamp and included a few instructions indicating the purpose of the probes and the tasks to be accomplished by the participants. The return address was written by hand in order to induce a level of casualness, creating the feeling that the participant was writing to a friend and not responding to a research study. The pictures on the postcards were chosen so that they were aesthetically pleasant and interesting for the participant. A different picture was shown on the front of each postcard, but all contained the message "*Help us do research!*" in a jolty font. At the back, the postcard also contained a prepaid stamp, the return address in hand writing and a question concerning the road objects, the emotions of drivers, their interaction with other drivers and their perceived external environment while driving. Some examples of such questions include (the rest of the questions can be found in Appendix C.1):

- 'How do you think other drivers, pedestrians or bikers influence your emotions while driving?',
- 'What do you find interesting or annoying about the drivers around you?,
- 'What are you feeling or thinking while waiting for a traffic light to be green?'.

Some questions were intended to be open and somewhat vague, letting the respondent express their thoughts fully, but specifically enough to fit in the postcard's white space. Some other questions were more straightforward intending to get more concrete answers from participants, but preventing misleading their response in any direction. Questions like 'What do you like about driving?' or 'What causes you to be stressed while you drive?' were avoided, since they are assuming an emotional state to be already contained by the participant, such as their joy for driving or the supposition that they will experience stress at some point while they drive. These types of questions would be misleading the study terribly and provoking biased responses to the questions. The participants were instructed to think about the postcard's question as they drove and to write down an answer to the question as soon as they saw a relevant situation, experienced a relevant feeling or had an inspirational moment, and, of course, when they had an opportunity to answer without provoking an accident (i.e. while halted by a traffic light, being stuck in traffic or arrived to their destination). The participants were also asked to draw on the included map (Figure 4.1)

the route that they would most likely take towards their desired destination, and write down on the map places where their emotions where influenced in some way along their journey. They were specifically asked to avoid commenting on the *looks* of the road or writing down just what they observed, rather to mention how were their emotions influenced by what they saw during their trip to the final destination, i.e. statements like 'The colour and style of the houses is very pretty' were especially discouraged, while 'The colour of the houses makes me feel happy and relaxed, I drive slower to appreciate them' was given as a good example.

Around fifteen packages of envelopes, maps and postcards were created. The reason for creating only few packages of probes was to have an initial overview of how well participants would respond to the methodology and confirm the properness of this technique with relation to vehicles and the experience of driving. Ten of these packages where distributed to strangers within the city of Lund, Sweden. The envelope enclosing the map, the postcard and the instructions was put inside a small transparent plastic bag to avoid damage from the rain and was left on the windshield of random vehicles, usually parked around the School of Informatics building or central Lund. The envelopes were placed near a University building with the hope that people involved in the academia would have an interest to help research be done and thus more likely to return the filled material. The rest of the packages, five, were given to acquaintances or close friends who were provided with a more extended debrief on the study and explanation of the tasks to follow.

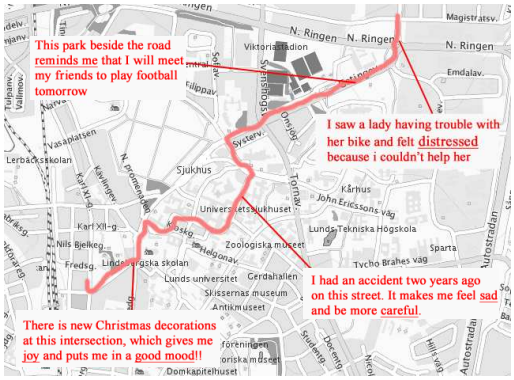


Figure 4.1: Map provided as an example to participants

In short, participants were supposed to write their comments on the map, write their answer to the question on the postcard, put the map inside the envelop and send the envelope and the postcard through regular post at their own convenience and not necessarily at the same time, which seemed pretty simple and straight forward instructions.

Results

The expectations were to receive the material filled with answers and comments within some weeks after the packages have been distributed. However, the results were extremely disappointing. Only two packages were returned out of the ten distributed to strangers, and of these two none was answered. Subjects submitted the envelope to the mail perhaps thinking that someone might have lost it on their windshield and returned it without answering the question or drawing on the map. This was a very unsatisfactory response, specially because of the high hopes and expectation that were put into this methodology, as well as the positive response rates reported by Gaver and others. The difference, perhaps, was that other studies that have used the probe methodology did not handed out probes to complete strangers at random, instead the researchers briefly introduced themselves and requested the participants to fill the probes with information in a more personal manner, similar to the five other packages allocated to acquaintances. Responses from this group of non-strangers or acquaintances were not great either. Out of the five packages handed out only three where handed back in, some of them being only partially completed, the map had no information but the question on the postcard was answered.

Perhaps better results could have been obtained if some aspects approach taken were modified a little. For example, researchers in other studies that had used probes targeted specific user groups, but the targeted group for this study can be seen as the whole set of *drivers* mostly in the city of Lund, which is a very broad category. Instead, the packages should have been distributed among certain clusters of potential participants, such as 'students of Lund's School of Informatics who own a car and use it daily', thus narrowing down the age range, the amount of people, their educational level, and the frequency of driving. Moreover, a more visible explanation about the study on the packages left on stranger's windshields would perhaps awaken the curiosity of the participant and response levels accordingly, or better yet, approaching the selected cohort of students personally and explaining the tasks and the intentions of the study briefly could have increase the level of response considerably. If the level of response would have been positive more probes of this type would have been created, with improved variables to be measured and a wider variety of questions to be asked, thus obtaining an ampler range of useful data on the emotions of driving to be analyzed.

Despite the negative results, it is believed that this same probe technique approached differently can provide better outcomes that the ones presented here. Unfortunately, personal budget and time didn't allow for a recreation of probes or for carrying out a second attempt from a different angle. It is left to the curiosity of an interested researcher to explore the alternative approaches to this same methodology applied to the study of emotions on the road.

4.1.2 Road Picture Gallery

Maps and postcards are not the only kinds of probes suggested by previous studies, nor are they the only probes used in this project. It is pretty much to the imagination of the researcher to create interesting *probes* to study the unknown factors of the world of users. Patricia Panqueva is an interaction designer whose thesis work also consisted on trying to capture the perceptions of road users while being mobile in an urban context [81]. Her idea was to ask friends who use the car as their main method of transportation in different cities (Berlin, Chicago, Umeå and Bogota) to take pictures of the road during their journey so that she could publish them on the internet (at Flickr, `http://www.flickr.com`), with the intention of creating a collection of pictures which serve as ways of communicating with people and ways of analyzing patterns of their perceptions while they travel by car. She found that participants liked to talk about the pictures they have taken since those pictures were their own creation and show small instances of their everyday routine of driving. It was a way for Panqueva to discover her participants' environment and to create a personal connection through a common interest, they were happy to discuss bits of their life with her and she was eager to get relevant information from them through the use of pictures.

The main purpose of taking and preserving pictures is to capture those instances that are not coming back. Photographs can become very personal objects, cherished and preserved for generations, mainly because they have the power of bringing back the memories of the moments in which they were taken, the persons you were with and the places you were at that particular instant. Pictures are not only physical papers with stamped images, but they also carry some sort of emotion with them. A single picture is capable of making us burst with laughter, sight from melancholy or cry of sadness, all by what its image represents. The image on a picture is augmented with previously felt emotions that can come to life as soon as we lay our eyes on it and start remembering the persons or events that were present at the time the picture was taken. Pictures also serve the purpose of sharing with others the moments that you lived far from those you show the pictures to, and they provide an easy way of communicating your previous experiences. Nowadays the use of a digital camera and mobile technology has given a new meaning to

the act of talking pictures. The ability to easily share your pictures with family members, friends and strangers over the internet has also changed the meaning of taking photographs. No longer are pictures just tools to recollect precious memories for you and your close ones, but also ways of sharing pieces of your life experiences with others, even with complete strangers. They are a way of broadcasting yourself as a person, portraying a desired identity and sharing your lived experiences.

Since pictures are ideal elicitors of memories they can bring valuable information on the emotions of drivers on the road, diminishing the fluid characteristic of experiences and providing an accurate account of the feelings of the driver at the particular moment when the picture was shot.

Procedure

Following Panqueva's ideas [81], a picture gallery was set up where participants could upload their images and add a comment on them. Flickr.com was not used in this case as a platform for managing pictures because the approach for this study was slightly different from Panqueva's, in the sense that it was intended for anybody to be allowed to upload their images without the need of creating an account or registering to a service. It was also intended to create a more specific gallery that dealt with the topic of emotions on the road exclusively, hence the gallery's name 'An Emotional Road', where anybody who accesses it could browse through the pictures of others without having to search an entire webpage, they could make comments on any posted photo and upload their own photos very simply, quickly and anonymously if it was so desired. The idea was that participants felt motivated to share their pictures on this specific subject, the road, without thinking of the tasks as a burden. Patricia Panqueva could only upload pictures to the Flickr gallery herself, so anyone who wanted to participate had to send his pictures to Patricia, whereas in 'An Emotional Road' gallery anyone could contribute with pictures at their own time without the need of a researcher posting them. The Open Source project of *Gallery Menalto* (`http://gallery.menalto.com/`) was employed to create and maintain *'An Emotional Road'* picture gallery, because it provided all the desired features described above. A few customizations were made to Gallery Menalto's source code to create a more personalized look and to make the navigation through the page and its interaction very simple and minimalistic, therefore encouraging people to participate. The gallery, which is hosted on a personal server, was lunch to the public on December 2006.

Approximately fourty persons from different cities around the world (Mexico City and Queretaro, Mexico; Lund and Ronneby, Sweden; Vancouver, Canada; Texas, USA; and Zargoza, Spain) were directly informed of the 'Emotional Road' gallery and their participation was requested through email or telephone. However, the intention was that strangers browsing the internet and curious about the study would also share their experiences through pictures in these gallery. The existence of the gallery was also divulged through *Microsoft Messenger*, this thesis' webpage (*`http://road.sytes.net`*), and some internet communities such as *Facebook*. Participants were given instructions on the kind of situations that they should be observant while driving and take pictures of.

At the beginning the instructions were perhaps not so clear, and people started uploading images that deviated a little from the subject of emotions on the road, but which provided with interesting observations on road usage and the road contexts. The instructions were later clarified, and presented to participants with the following text:

Picture Gallery

The pictures you take are supposed to act as remainders of your actual experience. By taking pictures of the places, people or actions that provoked some kind of emotion in you, you are able to recall those emotions easier later on. Taking a video of your experience would perhaps provide richer information.

What should You take pictures of and comment on?

Feel free to take pictures of anything you want. It doesn't matter if it is a place, a situation, a person, other drivers, etc. Anything that will later remind you of that particular moment *and of your* actual experience*. Some examples of things you can reflect upon while you are driving include:*

- *What is your relation to the drivers in front of you, beside you, behind you?*
- *In which ways and in which situations do other drivers influence your moods?*
- *Why is it that some parts of a street or a highway make you feel happier, sadder, melancholic, frustrated, powerful, free, etc!?!*
- *How does the sounds around you (music, engine noises, wind, honks, etc.) affect your driving patterns?*
- *How does the lights around you (headlights, street lights, etc) affect the way you drive?*
- *What do you feel when you think of other people's vehicles?*
- *What do other drivers do that annoys you? What do they do that makes your day?!*
- *What have you noticed about the cars around you when you are traveling in highways?*
- *How do the other passengers inside the vehicle influence your experience on the Road?*
- *How some situations vary your moods, your experiences and what do those situations make you think and feel!?*

Feel free to comment on your pictures as freely as you wish. Go crazy expressing yourself and describing the ways in which that experience on the road impacted you. The pictures you take and the comments you make can remain anonymous if you wish.

What you shouldn't do

Unfortunately, it would be of no use for this study if you submit pictures and comments on how the city looks*. Try not to comment on the beauty of buildings, the dirtiness of the street, or how the flower arrangements make a park look pretty. However, you can comment on how a building makes you feel and why, the emotions of disgust that street pollution causes in you, or the happiness you felt due to the flowers in the park.*

Where do I submit my pictures?

In this webpage http://road.servepics.com/gallery2

Note that the questions provided in the instructions are just suggestions of possible scenarios that participants could be taking pictures of, but not an actual questionnaire.

Results

The best results were not obtained when the gallery was first advertised and the participants were requested to take pictures of the road, post them and comment their feelings on them. The comments on the pictures proved that it is hard for individuals in general to discern the feelings experienced at a particular instant and express them in writing in a concrete way. Instead, people tended to take pictures of the road side and to comment on their surroundings, rather than recalling their emotions and commenting on the traffic and the actual context of the road. After the modification of the instructions the results were slightly improved, probably due to the example questions suggesting what should they think about and take pictures of while driving.

Table A.1, presented in the Appendix, shows some of the most interesting pictures uploaded to the 'Emotional Road' picture gallery along with the comments provided by the picture's owners, (in the case where the picture had comments in Spanish the comments were translated to the best of our knowledge into the English language). These comments were analyzed by their use of words, the choice of nouns or adjectives and the context in which the picture was taken. The context was deduced mainly by what the image showed, but also by the country in which it was taken, and it was very relevant for the interpretation of emotions. For example, in one picture the participant noted '*El precioso tráfico*' (which translates to '*The beautiful traffic*') with an image showing cars all around, not moving, obviously being stock in traffic, which can easily be interpreted as a sarcastic comment and possibly depicts the annoyance or frustration of the driver. The interpretation of these photographs and their comments can be easily mapped to Larsen's circumplex model of emotions [64] presented earlier in the previous chapter (Figure 3.3) and shown in the column of the table named 'Interpreted Emotion'. In order to obtain the results in this column of interpreted emotions and to avoid biased interpretations by the researchers, a group of four people unrelated to the study were asked for their collaboration. They were asked to read the comments given to each picture and match it to one of the eight affective states presented by Larsen's circumplex of affect. In the case where there was a disagreement or a tie in the opinions, the researchers' objective judgment was used. In general, these four people did not find the tasks of classifying some of the comments easy, although they thought it was interesting, many times they had trouble deciding on one category, specially in comments that portrayed two emotions, such as "we were excited, but a little tired", or that were too vague, such as "A main road...Stuck in traffic." Similar difficulties were encountered when trying to interpret the emotions of strangers that like to share their experiences and express their opinions through the use of internet web logs, which will be presented in the following section.

4.1.3 Web-logs as means of finding strangers' driving experiences

Blogs, video logs, online diaries, and discussion forums have gain increasing popularity among the regular internet users since their conception in the 1990's, and *blogging* is now seen as a common social activity that already has around 1.3 million related websites and it is continuously growing [39]. Their simplicity in use and the ease in which one can set up a new web-log account and upload his thoughts through writings, pictures and video are some of the factors that account for their popularity. But their main appeal lies in the opportunity it provides *bloggers* to express themselves in different ways with a faint factor of voluntary anonymity. The reason people like to share their personal, sometimes intimate, experiences with millions of other readers is still somewhat of a mystery, given that private diaries are usually kept in secrecy and intended for personal use only. However, web-logs have been compared to a radio broadcast, rather than personal diaries [73], but truth is that blogs provide "individualistic, intimate forms of self-expression" [39], from people who like to share their life through pictures, videos, text blogs, internet communi-

ties, etc. and their increase in use shows people's tendency towards portraying their daily lives to others.

Text web-logs are commonly referred to as *blogs*, where "bloggers write about their experiences, opinions and emotions" [67]. Video web-logs, also called *vlogs*, also provide a way for people to share their experiences through video, which can capture a variety of details usually not mentioned in the narrative form of an event. "As a result, blogs provide naturally occurring windows into people's thoughts and feelings" [67]. The activity of posting web-logs has also made bloggers more aware of their surroundings and own activities, making them more observant of the world around them, and also to articulate better the actions of others [39]. Some blog enthusiast might even become more attentive of their environment in order to have *something to blog about*, either through text, video or other media. Herring et al. [39] have identified three main types of blogs: blogs created by individuals as personal diaries, blogs intended to provide knowledge and blogs that serve as filters of information from other websites. It is the personal web-logs that are of interests for this study and which will be investigated further.

Unfortunately, few or none known empirical studies have been made on the actual reliability of the information presented on personal text blogs. As a matter of fact, there is nothing to stop bloggers from posting fabricated fictitious narration of events, experiences or stories of an unreal life they would like to portray to others. Even when their stories are truthful, they might tend to exaggerate the actual occurrences, or recount only those episodic moments that they are able to recall and conveniently leave out the sections that they wouldn't like to share but nevertheless form part of their experience. Furthermore, text blogs present the same disadvantage as regular questionnaires, that is, the cognitive processes of remembering past events and recalling only its most relevant incidents, leaving out the details and greats amount of the richness that constitutes an experience. It is left to the discretion of the researcher who uses text blogs as empirical material to objectively decide if the writings of a blog post are real enough or unreliably fictitious, as well as to be aware that the blogger will tend to leave out important details of his actions, internal emotions and surrounding environment.

Ideally, individuals would blog their experiences as they take place, leaving out some of the disadvantages of text blogs just mentioned. Fortunately, video-logs, or vlogs, provide ways for which an individual can capture his experience at that same instant, and share it with millions of others, friends and strangers, through the Internet. Video blogs do not only provide images of the occurrences, which serve as proof of their veracity, but they also contain sounds, which can be important in the process of looking at the details of a stranger's experience. Luckily for sociology researchers, technological developments, such as fast connections to the internet, high resolution cameras, and large storage capabilities, have made the posting of vlogs extremely popular, which can be advantageous when studying people's way of life.

Procedure

The procedure for collecting relevant information through web-logs was simple and aided greatly by the available resourceful functionalities provided by Google.com, Technorati.com, YouTube.com, and similar websites. Google gives the possibility of searching from millions of blog posts from different blog services (`http://www.google.com/blogsearch`). In order to get some related information on the experiences of bloggers driving, relevant keywords were inserted into, mainly, google's blog search engine, with the use of regular expressions. Keywords included single words or phrases such as *"driving experience"*, *"night driving"*, *"I was driving"*, *"driving" and "listening to"*, *"driving" and "sun"*, *"driving through"*, etc. The blog service *LiveJournal.com*, which has approximately over 2 million active users [67], allows its users to expressed

the mood related to the blog entry by tagging the post with a variety of *moods* [67], a feature that was beneficial for this particular study, since it allows disambiguation of the actual emotion felt by the blogger with less interpretation from the reader. Hence, many of the searchers queried on google.com were filtered out in order to return results only from LiveJournal.

Plenty of blog entries were returned with each search, most of which were very recent (posted after February 2007), some of which were quickly browsed, but eventually only those that were considered relevant, truthful and providing valuable information for the study were saved with the use of google's notebook (`http://www.google.com/notebook`), a plug-in provided by google which lets its user save any kind of internet content simply by selecting it, right-clicking on it and choosing *'Note this (Google Notebook)'* (in Internet Explorer).

Besides text blogs, video web-logs were also collected and considered as being a more reliable source, since common bloggers usually post their videos as they are, without any editing, hence they represent a real account of events. YouTube.com and DailyMotion.com are two of the many sites that provide video sharing through the Internet. Most of the videos used as probes for this study were collected with YouTube, which allows searching through their huge collection of posted videos with the use of keywords and tags. Moreover, a small panel to the left shows a lists of *Related* videos, which makes it simpler to find videos associated with the characteristics we were looking for. Again, the searches were made with relevant keywords that expected to return results corresponding to the experience of driving. The idea was to collect some posted videos which showed the spontaneous recording of people's experiences while driving; edited films or acted recordings were discarded, and hours of video-watching were spent in the search of relevant natural and unplanned recordings of people commenting on the road, interacting with their friends, and in general showing some kind of emotion while they were driving, either by themselves or with accompanying passengers, but almost always surrounded by neighboring vehicles. The chosen videos were saved for later analysis with the help of YouTube's features which allow its users to add videos to a selected group of favorites and also to post videos with comments in a personal blog. Another good characteristic was that video owners are allowed to write short descriptions of their videos, which were useful on the interpretation of their experience.

Results

The collection of all text blogs compiled into Google Notebook can be found on `http://www.google.com/notebook/public/10340502487383606747/BDQbIQgoQ89rzt6ci`. Around thirty entries where saved, many of these entries were not used on the final analysis of the collected material, while some others were useful towards arriving at fruitful conclusions, and can be found in Table C.1 of Appendix C.2. Google notebook provides useful advantages; one is that it allows searching for keywords within the notebook. This might proof useful for the analysis part when searching for keywords can narrow down the relevant blogs that are related to particular factors. The second advantage is that it allows writing comments for each entry, a functionality that was used in some entries to state the emotions portrayed by the writing of the blogger according to Larsen's circumplex (Figure 3.3).

YouTube has many videos tagged with the words *driving* and *experience* corresponding to the activity of driving sport race cars or fancy new vehicles in a racing ring, which was not useful for this study. Also, YouTube hosts plenty of videos of people setting up their camera in front of their steering wheel and recording the road without verbally commenting on it, usually editing their videos to speed up the frames or to put some background music, which were nice to look at sometimes but also not helpful for this particular purpose. However, plenty of relevant videos were found of people willingly recording their experience at spontaneous moments or commenting

in their recordings with truthful opinions, and willingly sharing it with others. Not all of the videos portrayed a positive driving experience, some of them show drivers amazed at the ways of driving of different cultures, some others express their emotions towards the driving patterns of other drivers. Around thirty videos were collected in total and can be found in both a group on YouTube (`http://www.youtube.com/group/emotionalroad`) and as posts in `http://anemotionalroad.blogspot.com/`.

4.1.4 Findings from the Cultural Probes

Cultural Probes is not a perfect research methodology, as is perhaps any other research methodology on the field of design. Even advocates of the use of probes recognize that they are not ideal tools, since "there is an element of risk in deploying probes: they might fail or bring unexpected results" [47]. The unsuccessful use of postcards and maps as cultural probes for this study puts in question the success reported by previous studies when using probes under certain settings or for certain purposes. Applied to the right situations with a well defined cohort of people the probe methodology could prove to be useful, but it appears that the element of success for making good use of the probe methodology is the essentiality of communication and of direct contact of the researcher with the participants. The process of recruiting suited, committed participants for a study concerning probes is crucial, since the amount of time and effort required by the participant to complete certain probes can be substantial, therefore handing out probes to strangers who have no motivation or reason to participate in an unfamiliar study might not be a good idea. The remaining challenge is to identify the situations and user groups for which probes might work bests, such as elders, children, animals or any other group presenting difficulties at communicating their needs and desires. Inspired by Cultural probes, other researchers have suggested the use of Urban Probes [82], Technology Probes [47] and Domestic Probes, which suggest the idea of creating 'Traffic Probes'. These can be a set of tools and materials, just as cultural probes, designed specifically for the road environment with the purpose of capturing the road user's opinion, and that could provide the necessary insights for developing mobile technology for the road. Mobile web-logs, also called moblogs and described further in section 4.4, could be an example of a possible traffic probe.

The initiative of Panqueva [81] of taking pictures of the road and discuss them later with their owners could be another kind of traffic probe. The pictures uploaded to the *'Emotional Road'* gallery were perhaps the most useful collected probe material. Through those pictures people showed their contexts and their interest in the aspects of traffic. Participants who uploaded pictures were mainly from Mexico City and from different parts of Sweden, which are two very different road environments, one characterized by competitiveness, aggression and fight for power, and the other one tends to be a calm, polite and spacious kind of driving, characteristics that were corroborated by the pictures and their comments. Although some of those pictures were useful and interesting to analyze, others were totally out of the contexts of the study, yet they showed a tendency of people to express their road usage experiences and their involvement with the city and their culture. Some pictures were not necessarily about driving, but about the behaviours of people on the road and the daily life of road users, a topic that is out of the scope of this thesis but that might be of interest to works related with social computing or any other that seeks to augment streets with technology aimed at supporting road users other than drivers.

From the web-logs encountered through web searches, some useful information can also be obtained. However, it is important to remark that the collection of web-logs, specially text blogs, was intended to serve mostly as supporting evidence for the rest of the gathered material and not as factual proof of drivers experiences. *YouTube.com* and many other video diaries services, provide ways of communicating with the creator of the videos through messages and comments.

The idea of contacting the creators of the blogs was not thought of until later in the process of collecting the material for this methodological proposal. Now we realize that communicating with the persons who purposely posted their writings and videos with the intention of conveying an idea, might have provided with better quality of results and a richer discussion on what they were actually experiencing at the moment they were capturing the video or when their written stories occurred. An advice for interested researchers on using web-logs as a medium to capture the user experience is to not only examine the posted material, but also attempt to contact the originators of such material in order to obtain more truthful explanations of the experiences by the people who went through it and do not rely on mere interpretation. Users of YouTube, for example, usually and passionately respond to the comments given to their posted videos. This webpage even provides the opportunity of replying to a video with another video, which might create interesting and original discussions if they are properly moderated. Even when we did not personally communicate with the creators of the web-logs, examining the comments from others and their replies provided a more meaningful interpretation.

Recall that the site LiveJournal.com, allows bloggers to report their moods according to their stories. Previous research has indicated that the most frequent moods reported in LiveJournal are "tired, amused, happy, bored, blah, cheerful, content, sleepy, excited, and calm" [67]. Notice how these reports do not include many moods related to anger, frustration, nervousness, or other not positive emotions, which is a hint of the biasness of the reports. People might tend to share their good experiences with others and be conscious of the opinion of their readers or viewers, therefore leaving out the experiences that are not so positive or that do not portray a joyful way of life. As previously mentioned, web-logs, specially text blogs, have many flaws if they are considered to be used as empirical material, since bloggers have to make use of their retrospective memories and their stories can fictitious narration of events. The intention of collecting people's experiences through web-blogs was not to arrive to definite conclusions, but rather to support and complement the material obtained from other probes and methods, such as ethnography studies and the Experience Sampling Method, both of which will be outlined in the following sections.

4.2 Ethnography and other observations

The previous section described the concept of Cultural Probes as a method to capture the user experience and presented the tools that were used in this study considered as probes, i.e. the Postcards and Maps, Picture Gallery, and Web-logs. Notice that with all of these probes the researcher or designer does not need to be physically present to collect useful data, avoiding the possibly obtrusive presence of an external observer, but rather the participants are supposed to return the data whenever they feel comfortable and in their own spare time.

In ethnography the complete opposite occurs. The researcher's job is to capture the every detail of the user's processes and practices, as well as their interactions, their surroundings and their movements by being actively involved. Having its roots in the fields of anthropology, ethnography is very concerned with the social study of groups of people, which not only returns detailed descriptions of their activities and their unfolding context, but also tries to understand the underlying motives for their actions, the reasons for their behaviors and the elicitors of their emotions. To do this, ethnographers go beyond the simple recording of their observations characterized by anthropologist, and they actually engage themselves into the surrounding culture that is under examination. They ask questions and provoke responses without trying to interfere in the actual activity, but mostly observe and listen attentively, having a kin eye for details and the factors that compose an experience. The results from applying ethnographic methods could be a set of textual notes, voice recordings, video footage, photographs, etc., with high levels of ecological validity.

Ethnography is a recognized research method that allows the collection and analysis of empirical field data [80], which can be a prolonged through time or made 'quick and dirty' to gather a general overview of the user's activities.

In the process for designing for ubiquitous technologies and context-aware devices, the role of the ethnographer takes a slightly different turn from its original conception, since the range of possible interactions encountered by this new paradigm are vast and take new forms. For the particular activity of driving, these interactions unfold under a mobile context, which "are created and maintained by *situated actions in everyday life*" [110], presenting another challenge for ethnographers to discover. Moreover, the ethnographer has to be vigilant of the many possible interrelations between humans and invisible machines. As stated by Cabtree et al. "ubiquitous computing is explicitly concerned with the setting in which interaction occurs and how this may be exploited to shape user experiences" [16]. From the relationship of ethnography and its application to the design and development of technology comes the term *technometodology* [27], which combines the study of people's methods and their share understanding of each other's actions, which corresponds to the social term of *ethnomethodology* developed by Harold Garfinkel [121].

Ethnographic methodologies present the disadvantage of being time consuming and interpretive, depending on the context and the subjectivity of the researcher. An ethnographer has to be skilled at observing the activities of people under their natural environment, which is a skill not possessed by anyone and that comes with training. Moreover, the results from ethnographic studies are not always easy to translate into practical and usable purposes, such as the development of technologies to support human activity. The lengthy descriptions and vast amounts of collected material are often hard to analyze and concretize; but if properly applied, their use can result into real understanding systems that might bring benefits to the appropriate environments.

For the purposes of this study two main approaches related to ethnography were followed, one approach invited the participants to verbally express their actions, thoughts and, in particular, emotions as they traveled by car, while the other one tried to capture, through video and written notes the emotional states of their participants with their spontaneous comments and reactions to unplanned road events. Both of these alternatives are presented in the following sections.

4.2.1 Talk-Aloud-Protocol

A common procedure for usability testing within the field of interaction design is the Talk-aloud-protocol, which involves getting the participants to explicitly say what they are doing or thinking while performing a specific given tasks. The use of this approach for this particular study was motivated by a previous study which evaluated, by a triangulation of data, the effects that the interaction between the driver and the car's dashboard interface had on the emotions of the driver [34]. "The basic principle of [Talk Aloud] is to ask users to work on typical tasks and to verbalize their task performance and thought process" [88]. This method has been widely used in many other studies that usually have the purpose of evaluating the usability of a specific user interface or product. However, this study will consider the talk-aloud methodology to inform the design of possible technologies, instead of evaluating any existing prototypes or interfaces. In particular, through the use of this method we intended to capture, from their own mouths, the experience of drivers as they traveled by car, therefore providing us with recorded proof of the emotional experience of drivers from their own account.

The talk-aloud-protocol is not flawless and has also been criticized. One of its disadvantages is what critics called the factor of *reactivity*, or the impairment of the performance of an individual while trying to talk and to perform the studied activity at the same time [88]. However,

practitioners of this approach argue that the participants' sequence of thoughts is not affected as long as there is no introspection [62], people are good at describing with words the actions in which they are engaging in, but they have difficulty on expressing why are they doing it. Another disadvantage of this method is that participants become aware that they are under constant observation, which might create the belief that their actions are being judged by the observers, therefore modifying their behavior or utterances to create better impressions.

Procedure

The think-aloud method was applied on three different occasions, during different times of the first half of the year (between the months of January and April), each with a different driver who traveled by car through some streets and highways of southern Sweden. In two of these three occasions a *Ford Ka* vehicle was used, and a *Volvo V5* was driven on the third trial. The participants were asked to explicitly utter aloud their internal feelings as they drove through a specified path, identifying, whenever possible, those aspects of the road environment that could be perceived and that were identified as the elicitors of such emotions. The participants were encouraged to express themselves with freedom and confidence, without thinking too much on the coherence of their utterances, but rather trying to provide truthful accounts of their internal feelings. Segments from the experiences of the three subjects were recorded through video and sound, while at the same time notes were taken on the important encountered events. The duration of each trip was around 20 to 40 minutes, all of them taking place before dusk, and usually included a combination of driving on city streets and highways. On two of these occasions the driver was accompanied only by one passenger, and one of the trials included two passengers more beside the driver in the car.

Results

People who agreed on participating on this method were found to be surprisingly shy at the moment of expressing aloud their thoughts and emotions as they traveled. They had to be constantly provoked to actually talk aloud as they drove. Eventually, valuable written observations were obtained and approximately twenty minutes of video footage were recorded in each of the trials, depicting the experiences of the participants while driving. Relevant episodic moments were extracted from the video recordings and further reduced to short clips, most of which were uploaded to YouTube.com and can be seen at `http://www.youtube.com/djjupa`. Through the videoclips, besides capturing the voice of the individuals as they spoke, many other details of the road and the happenings at the moment the participants were describing their emotions were captured. These video clips, just as pictures, serve as reminders of the occurrence of the actual events, and aid the researcher at recalling the experience that was trying to be captured. Their detailed examinations at a later time also provided for many clues that could have been unnoticed at that particular moment, and could lead to fruitful interpretation of the experience.

The use of this method reaffirmed the hypothesis that drivers are usually unaware and unaccountable for their own emotions. It appeared to be extremely hard for them to produce a detailed description of their inward emotions, perhaps because emotions are usually *simply felt* and occasionally expressed through actions or behaviours, but not as often through words.

In general, the talk-aloud-protocol offered some valuable insights, but presented the disadvantage of having to force people to express themselves. To account for some of the deficiencies that the Talk-Aloud-Protocol presents a similar approach was undertaken, but with the difference that it tried to construe the emotions of drivers from their observable behaviours instead than only

from their verbal expressions. This approach is presented next and has been previously called *The Shadow Method* [81].

4.2.2 Shadow method

Opposite to the talk-aloud-protocol, where subjects are asked to explicitly express their actions or emotions, the participant of the Shadow Method takes a more unintended role, in the sense that he is left to perform his actions in an more ordinary and natural way, without being instructed by the researcher of doing particular tasks and sometimes not even being aware that his actions are being monitored. The ethnographer in this case acts like the participant's or user's *shadow*, simply following his moves, engaging in his same activities and trying to perceive the word from his point of view [81].

Procedure

In three other occasions three different participants were asked to drive a Ford Ka vehicle. The trials took place in the streets of southwest Sweden between the months of February and March and mostly under a dark environment, since the sun sets rather soon during those months. Participants were commented that we would like to videotape their experience while they drove the vehicle and they decided on a path to follow or a destination, as well as the passengers they wanted to carry in the car, besides the researcher. The researcher sat always at the backseat with a partially fixed video camera and a notebook on his lap to record relevant episodes or comments from the driver. The camera was positioned in a way that tried to be as unobtrusive for the driver as possible, with the intention that it would eventually fade away, or become invisible, embedded into the driver's environment, as if it was part of the car's accessories. For this reason, long journeys were preferable and sometimes encouraged, with the hopes that as time passed by the driver would become less aware of the presence of a camera and of a researcher.

Results

Some video footage was obtained from the relevant segments on the road, and the camera was turned off while cruising through long dark roads without vehicles around. The long videos were also reduced to short clips containing the relevant episodes of the experience and can be watched at `http://www.youtube.com/djjupa`.

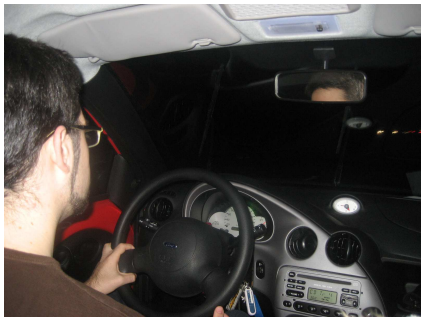


Figure 4.2: Picture of one of the participants of the shadow method. Driving at night through the highway from Lund to Helsingborg.

In one occasion the vehicle had five passengers including the driver and the researcher, who decided to travel from the city of Lund to Helsinborg (Figure 4.2). The passengers knew each other and were laughing and joking for the beginning of the ride, however felt silent mostly when traveling through the long solitary highways in the middle of the evening, as if the environment had made them sleepy, weary or distracted. Dancing music was playing through most of the journey, which can be a factor accounting for their silence, or perhaps the considerable amount of road noise perceived inside the Ford Ka which

make it harder for the passengers to hear what the others were saying; however, the passengers lack of conversation might have also been due to the fact that they all knew the journey was being recorded through video and sound. The driver appeared to be very attentive through most of the journey. His personality is usually of a quiet and precautious nature; the quietness and long empty streets allowed him to think on other things too, he commented sporadically in some aspects of the road or participated in the initial conversations. Some of the relevant comments he made include:

Comment	**Event**
'I want to dance now'	Dancing music playing loud at the beginning of the journey.
'This car has trouble with five people in it'	Driving through a steady long uphill in the highway.
'This car is not very stable'	With an expression of worry after having taken a sharp curve at high speed.
'Why the hell is the guy behind on my heels. I hate it when people pressure me or tailgate'	With an angry tone after another car behind was tailgating the driver in the highway.
'I can see less because of the rain'	Apparently nervous while reducing his speed and speeding up the windshield wipers.

In the other two occasions the trips were made between the cities of Malmö and Lund, with four passengers in the car and most driving took place in Malmö's city streets. One of the trips was made when natural light was still illuminating the streets while the other one was in the late evening. Unfortunately the car's noise sometimes didn't allow for good audio to be captured, or for the passengers to engage in interesting conversations. From the recorded comments through the two journeys, the following were some of the relevant ones:

Comment	**Event**
'I love that song'	Music playing from the car's radio. Driver singing happily after it and rhythmically tapping the steering wheel.
'I am not used to drive like this'	Driver is from another country and recognizes the emptiness of the Swedish streets.
'Here I think I have to follow the rules'	Driver was being serious but also kind of joking, while observing the behaviour of other drivers.
'This car is the one that my parents want to buy because is big and strong'	Driver pointing at another car slightly ahead and in the left lane.
'We need to park somewhere'	Driver getting stressed at the inability of finding parking space and his little knowledge of the city's streets.

4.2.3 Findings from Ethnography Methods

As mentioned before, some professionals argue that the talk-aloud protocol works as long as there is no introspection from part of the participant. However, notice that drivers, when trying to express their own emotions, are actually engaging in introspection, which might account for their difficulty and their shyness when trying to perform their driving while cognitively working to identify and express their emotions. On the other hand, the shadow method doesn't involve introspection and the subjects express themselves naturally, nevertheless their awareness towards the camera and the fact that their actions are being recorded can affect the outcome of their behaviour. The Talk-Aloud-Protocol provided a hint towards what really constitutes the driving experience. Being unaccountable for their emotions, drivers become more consciously aware of the actual events that occur around them and how these events limit or expand their range of possibilities or actions that they can or cannot perform upon the road. Their actual experience, in this sense, is not solely dictated by their emotions, since they are not consciously aware of their presence, but rather by the spontaneous and momentary events that enrich their ever-changing contexts. In one occasion, for example, the driver was blinded by the sun and expressed her annoyance aloud; this same annoyance could not have existed under a slightly different context, such as her driving ten meters ahead or traveling at a slightly different angle. Therefore, it is important to remark that the actual understanding of the emotions of drivers become irrelevant without an explanation of the context in which they are actually experienced.

Observations of this type were reaffirmed by the shadow method. During the shadow method trials, the comments and utterances made by participants tended to express their experience at that moment in relation to previous experiences. For instance, when the foreign driver mentioned "Here I have to follow the rules" it implies a comparison to his previous experiences driving in his own country. Similarly, when the other driver commented "This car is not very stable" or "This car has trouble with five people in it", he was basing his comments, and consequently his experience, in some previous lived experiences driving different types of cars at different points in time. If the drivers hadn't driven on previous occasions under different contexts that provoked different sets of emotions, they wouldn't have anything to base their current experiences on. This suggests that experiences are built with time and frequency of performance, and serves as an explanation for the differences in emotions and behaviours between novice drivers and *experienced* drivers. The emotions felt for the same activity evolve and change as an experience matures. A person might undergo feelings of nervousness and anxiety during the first couple of days at a new job; however, those feelings subside with the passing of time and with the engagement of each of the experiences of going to work with certain frequency. A similar situation occurs with a novice driver, whose actions while driving are very marked and influenced by certain feelings of negative alertness; yet, every new attempt at driving provides him with an experience and a constant learning of the positive and negative practices that constitute the act of driving. He, then, accumulates this learning through each attempt at performing the activity of driving and comparing his set of lived experiences under similar contexts, till the point when he no longer is commanded by, or even aware of, his emotions while driving, allowing him to perform the activity in a routinary fashion.

Following this train of thought, it might be interesting to study the feelings of experienced drivers while driving in the opposite side of the road for the first time; for instance, a person who has driven in Sweden for many years trying to drive in the United Kingdom for the first time, or vice versa. A wild guess for this special case would be that experience drivers traveling for the first time on very difference settings would not undergo the same emotions, or at least not the same intensity of emotions, as a person who is driving a car for the first time ever. The factor at play in this situation would be familiarity; experienced drivers are familiar with the activity of driving, their brain has formed the necessary mental models that allow them to understand the complexity of the situation, also to predetermine the possible actions of others and to comprehend

the permissive laws of the changing contexts, making them more astute, agile and better at learning under new environments but of the same activity, which are abilities that novice drivers are just acquiring.

Generally speaking, ethnography studies are good resources for investigation of everyday activities. The quantity of video material and accompanying written notes proved to be useful at arriving to some conclusions and analyses that might not be completely obvious from initial observations. Even when the material itself wasn't difficult to collect, the actual examination of the vast amount of video footage, or attempt to discern the "commonsense methods by which people manage and organize their everyday behaviour" [27] while driving (i.e. the application of ethnomethodology), proved to be wearing and time consuming, but hopefully worthwhile. Methods for capturing experiences with faster rates of return of material could perhaps compensate for the possibly lengthy application of ethnographic studies. For this reason a method that aims at getting information faster and from possibly remote locations, called the Experience Sampling Method, was also applied and presented in the following section.

4.3 Experience Sampling Method

The Experience Sampling Method is a research methodology proposed by Reed Larson and Mihaly Csikszentmihalyi in the early 1980s, and is part of the *everyday experience methods* often used by sociologist and psychologist to capture the experience *in situ* of certain cohorts of people.

> "Everyday experience methods are designed to provide detailed descriptions of specific moments or events in a person's life, from which researchers can extract information about *'the persistence, cyclicity, change, and temporal structure of though, emotion, and behavior'* (Tennen, Suls, & Affleck, 1991, p.333, [112]), as well as identifying situational and dispositional correlates of these patters" [91].

One of the goals of this method is to eliminate retrospective bias [13], which was one of the disadvantages of using some of the blogs and normal interviews, by asking participants to produce an accurate and truthful account of their actions, internal emotional states and contexts as they engage in an activity. Furthermore, this method provides high levels of ecological validity by trying to capture the spontaneity of an individual's experience as it occurs in its natural environment (it is often called *Ecological Momentary Assessment* in the field of medicine [13]), which is exactly what this research study is trying to achieve with respect to the driving experience. This method is also ideal for accommodating many participants that are remotely located and under different environments [14], and therefore particularly well suited for this study. It might also be a good supplement of traditional ethnographic methods, having the advantage that the researcher does not have to be physically present, therefore avoiding the disruption or intervention into the users' activities, and also diminishing the factor of accountability, i.e. the users' conscious knowledge that their actions are being observed and studied. However, this method does not allow the researcher to perceive the whole ongoing context surrounding the user, neither can the researcher interact with the users in order to ask them questions and disambiguate some of their responses.

Methods for everyday experience originally consists on asking participants to carry with them a pager and a notebook at all times or some questionnaires for a period of time as they go on with their daily activities [19]. Nowadays, more sophisticated and convenient mobile technology can be used to contact participants during their normal routines, such as PDAs and mobile phones, as well as for them to return the data more practically, promptly and efficiently. Normally, the participant's pager, or other device, is signaled every so often as an indication that he must write down

immediately the answer to some questions on his notebook or questionnaire. There could be three ways in which a participant can be indicated to record his experience [91], *Interval-contingent Recording*, *Signal-contingent Recording* and *Event-contingent Recording*. In the interval contingent participants are reminded to note down his experience at reasonably spaced but fixed time intervals, which are meaningful for capturing certain activities during times of the day; for example, every five hours, every morning and night, every two days, etc. With the signal-contingent approach participants are indicated to write their experiences as soon as their pager or similar device receives a message or corresponding signal. In the event-contingent case, participants are asked to record their experience in the occurrence of a meaningful and unambiguous event, such as the ringing of the phone at night, or the engagement into a social conversation that lasts more than ten minutes [91]. Participants could be asked to record their experiences several times a day and for several periods of times, lasting weeks or even months, however the researchers have to be considerate of the burden put on the participant, the amount of data needed to arrive to empirical conclusions and the time allowed to collect such data.

Many studies have been reported using this method with success and for a variety of purposes, mainly within the disciplines of sociology and psychology [18, 19, 46, 55]. In the field of computing, the advantages of applying this method to inform and evaluate the design processes of new interactive systems and ubiquitous computing applications has been recognized by Sunny Consolvo and Miriam Walker from the Intel Research in Seattle [14], who are aware that the users of ubiquitous technologies act in a wide variety of natural contexts, thus the evaluation of such technologies should also be done *in situ*. A study made by Consolvo and Walker [14] on the evaluation of ubiquitous applications with the use of the Experience Sampling method, as well as the study done by Juslin and Sloboda [55] on understanding individuals' musical experience, inspired the use of a tailored version of this method for the purpose of capturing the drivers emotional experience, and a description of the followed procedure is presented below.

Procedure

Other studies that have employed the Experience Sampling Method mostly make use of pagers or beepers to signal their participants. For this study, there were not available pagers and beepers that could be handed out to the participants, instead they were asked to use their mobile phones, which are personal, provide the more functionality than a pager and their use is extremely common. Groups of friends and acquaintances from different countries and at different times of the year were asked to participate in the study. People who agreed to participate provided us with their mobile numbers and three of their most likely times of the day when they expected to be driving or inside a car with someone else driving. In return, they were given a seven page document (either in physical or digital format) and were asked to print it, carry it with them at all times, and were encouraged to provide their answers in a truthful manner. The document consisted of a page with an introductory message and instructions, five pages containing the same one-page questionnaire with thirteen questions in each page, and a page at the end exemplifying some possible answers to the questionnaire. The instructions given in the first page were the following (and translated to the Spanish language for the participants abroad):

Instructions (What are you suppose to do?):

- You are supposed to print out this document (and staple it for convenience).
- Once printed, carry these papers in your car at all times, until the five questionnaires are completed.
- You will receive SMSs on your mobile phone at random times. Usually they will be sent at times when you are most likely to be driving your car. Please ignore the SMS if you receive it at a time when you are not driving your car.
- As soon as you receive one SMS, please answer **one** of the pages in the questionnaire. If you are driving alone, then wait until you stop on the nearest traffic light or whenever you have a chance to write down your answers safely. If you are driving with a passenger, ask him/her to write down your answers on the paper while you continue driving.
- Whenever you have a chance (when you arrive home, work, school, etc.) access the internet, go to this page `http://road.servepics.com/` and fill in the online form with the same information you have in your paper. Click 'Submit' when done.
- Fill up the next page in the questionnaire when you receive the next SMS, submit it to the internet, and so on until you complete the five pages with questions.

Notice that drivers were instructed to fill out the questionnaire as soon as they could safely answer the questions after having received the signaling SMS on their phone or to ask a passenger to write down their answers while they talked. Some subjects reported being unable to receive an SMS and were then instructed to set an alarm some minutes after heading out for their journey and answer the questions as soon as the alarm went of. The purpose of sending SMSs or setting up the alarms was to create a certain degree of randomness on the response times and to provoke the spontaneity of their answers corresponding to the events taking place at that particular moment.

The thirteen questions asked are presented below:

1. What category would best describe your Current emotional state?

Happy / Glad	Tired / Sleepy	Annoyed / Frustrated
Serene / Contented	Bored	Afraid / Alarmed
Calm / Relaxed	Sad / Gloomy / Depressed	Tense / Stressed
	Upset / Distressed / Angry	Excited / Aroused

2. Describe in few words what do you think is influencing your emotional state:
3. Do you think other drivers around you have affected your current mood? How?
4. Think about the different **'lights'** around you (e.g., the sun, other's car lights, lights from your own car, street lights, etc.) How do lights affect or influence your driving experience?
5. How would you rate the song you are listening to?

Excellent	Bad	Nothing Special
Good	Really Bad	I'm not listening to music

6. Think about the different **'sounds'** around you (e.g. radio, engine noise, other cars, ambulances, etc). How do sounds affect or influence your driving experience?
7. How would you categorize the current amount of traffic?

Congested (Cars not moving)	Moderate (Some cars around me)
Heavy Traffic (Cars everywhere)	Light (The streets are almost empty)

8. How does the amount of traffic affects / influences your driving experience and your emotions?
9. Any other comments on your current feelings, emotions, or experience while you are driving??
10. Time of the day:

Morning	Afternoon
Evening	Night

11. How is the weather like right now?

Sunny	Rainy	Foggy
Partially Cloudy	Snowy	Windy
Cloudy		

12. How fast are you traveling approximately? (Speed in Km/hr)

0-30 km/hr	51-70 km/hr	91-110 km/hr
31-50 km/hr	71-90 km/hr	More than 110 km/hr

13. Are you traveling alone?

Some of the questions were set up according to some aspects of the road, i.e. its sounds, its lights, its traffic, etc., that were found to be prominent factors in the results of previous observations, mainly the ethnographic sessions. Participants were supposed to answer only one of the five questionnaires every time an SMS was received and only if they were actually traveling by car. However, more than five SMS were sent to each participant to compensate for the times that they were not in a car. The Internet calling software program *VoipBuster* was used to schedule the times for sending SMSs to the participants according to their preferred driving times. The scheduling was done at random during those intervals indicated by the participants and were sporadically spread within days, so that in some occasions a participant could receive more than one SMS per day or less than two in the course of three days. Once the subjects have filled one of the paper questionnaires, they were asked to submit their responses online as soon as they arrived to their destination and had access to the internet, by going to the website `http://road.servepics.com` which hosts a submittable form with questions identical to the ones on the questionnaire. The subjects were allowed to remain completely anonymous if they so desired to. What is more, the method was published on the internet and the seven page document could be downloaded in English or Spanish from the web (`http://road.servepics.com/phpfmg/Questionnaire.pdf`) by any internet user, to al-

low participation of interested strangers.

Results

A total of eleven different individuals responded to the call of participation, some of whom returned the answers to the questionnaires in all five occasions, while others did not complete the five. An overall of 29 responses were returned from the eleven participants, most of them, 21, were driving in the streets of Mexico, six were from Sweden and two responses came from the United States. The material was returned periodically by the participants over the course of some weeks, and was conveniently formatted and partially examined as it was received. The complete results, translated into English, can be seen in Tables B.1, B.2 and B.3 of the Appendix section (the complete table had to be divided into three in order to allow the data to fit in the pages). These results were further re-coded based on the communal interpretation of the information, and the findings were categorized into the most discovered prominent groups. Many of the written responses to the open questions were very specific and concrete while others were hard to classify and occasionally portrayed two different points of view in the same comment, making it harder to interpret into a single category. The entirely recoded results can be found in Table B.4. The recoding of the variables was done in cooperation with the help of non-participants who were asked to be objective to the comments and to map some of the answers to Larsen's circumplex in Figure 3.3. The coding of the variables provided an easier analysis and interesting observations that will be discussed through the subsequent chapters.

4.3.1 Findings from the Experience Sampling Method

The different variables of the questionnaire that needed to be recoded unveiled some interesting findings. The participants seemed to express themselves truthfully, perhaps because many of them were unaccompanied in the car, with no one to observe their action or their responses. Knowing that they would provide their answers through the internet without the need of meeting their reader at any point seemed to provide another layer of anonymity, allowing them to express their answers with more fervor. From the very general question *what do you think is influencing your emotional state?* four main groups of responses were identified; thus, according to the recoded responses of the Experience Sampling Method participants emotions are influenced, for better or for worst, by four main generic road factors, namely *other road users*, *amount of traffic*, *external environment* and *traffic objects*. *Other road users* constitutes any other individuals that are acting on the road, which could include other drivers as well, but also pedestrians, merchants, bikers, etc. The *amount of traffic* was one of the most prominent factors that people reported as affecting their moods while driving, which could be divided into heavy traffic or light traffic. By *external environment* we refer to any other factor that is able to affect the emotions of the driver that has its source outside the context of the road, for example the sunsets, the landscapes, the chirping or birds, etc. *Traffic objects* refer to the elements positioned, usually by traffic authorities, within the road environment that serve a certain purpose, such as traffic lights, traffic signs, speed limits, etc.

Participants stated three main characteristics of the interaction with other drivers that are able to affect their own moods, which are the *attitude and emotions of other drivers*, the *careless driving* of others, and the *quantity of cars* on the road. From the question asking the influence of light, also three main sources were discovered, *natural lights*, *road lights* and *lights from other vehicles*, each which can have good or bad influences on emotions. The sources of sound were divided into five categories: *other vehicle's sounds*, *road users sounds*, *own vehicle's sounds*, *music from the stereo* and sounds from *the external environment*.

The amount of data collected for the Experience Sampling Method (n=29) is perhaps insufficient to have any statistical significance; however the intention of presenting these results is to show the initial tendencies of the drivers' behaviours and experiences. A more throughout and concise experiment would be needed to confirm these findings with some level statistical relevance. Nevertheless, the beneficial return of applying an everyday experience method is a "detailed, accurate, and multifaceted portrait of social behavior embedded in its natural context" [91]. Moreover, this method can provide quantitative and qualitative data, making it possible to be analyzed statistically, and perhaps serving as a good supplement for the other employed methods, such as ethnographic methods, so popular nowadays for informing the design of ubiquitous applications.

This method seems like a promising approach for the design of computerized systems, which main objects of attention and the motives for developing technology are rooted in the users, their contexts and their experiences in situ, and look for ways to support these three aspects. Designers of interaction and ubiquitous computing need to capture the essentiality of routinary actions while they happen under their natural contexts/ The rapid rise and advancement of some low-cost mobile technologies might allow different alternatives of the application of this same method to a wide variety of different settings, with more reliable signals, quicker responses, and various forms of data (such as text, pictures, video, voice, etc). Exploring the results obtained from the combined used of mobile web-logs, or Moblogs, and the Experience Sampling Method could be a good start.

4.4 Summary

4.4.1 Comparison of Methods

All the methods could have some disadvantages and advantages. By employing different methods to study the same thing, we are trying to account for the disadvantages of some of these methods.

One advantage of using web-logs, for example, is that bloggers come from all around the word and from a wide variety of backgrounds. The Experience Sampling Method can also provide data from different parts of the world since it can be applied remotely. Another advantage of web-logs is that very little user participation is required; the data is voluntarily collected by people as a hobby and who willingly sharing their experience with the world and available for researchers who want to analyze it through this approach. On the other hand, the picture gallery probes and the Experience Sampling Method require a little bit more effort from the participants, since they have to either take a picture, submit it and comment on it, or to think about their answers, fill a questionnaire and then sent their answers when possible. In the Talk-aloud protocol the participants had to perform a lot of cognitive activity at the moment of reflecting upon their internal emotions, and even though they were shy at some points they seemed curious and interested on the experiment. For the shadow method participants had to do almost no effort, since they were supposed to act normally as they would do in any other driving day. They happily volunteered to participate in an activity that involves driving and that they tend to enjoy. The disadvantage of these two ethnographic methods is the actual presence of an external entity into the actual environment, in this case the existence of a researcher with a camera inside the car.

Regarding the cultural probes, one of the disadvantages of using certain probes as ways of capturing the users' opinion is the considerable amount of time that researchers have to invest in developing or setting up the probes, tracking the participants and later analyzing their results. Good practice could be to develop few and lightweight versions of the probes during the initial stages of the design process and hand them out to participant in order to observe their reactions

and levels of response, thereafter make changes to the instructions, the design and the planning of the probes accordingly, which will hopefully generate better results. From the presented probes used in this study, all of them were very time consuming in different ways. The creation of the postcards and their instructions took a lot of time, the setting up of the internet picture gallery was also very time consuming, and the time it took for participants to return or post material was significant too. From the experience of collecting data from web-logs, it also took a lot of time to look for information, read some of the blogs and watch the vlogs.

Fortunately, a new fairly new form of blogging, which includes the use of *Moblogs* or mobile web-logs and which allows people to post blog entries from portable devices such as mobile phones and PDAs, will permit the researcher to obtain a more rapid return of material in a nicely formatted way. This blogging alternative will allow users to post relevant elements of their experience as it is taking place, therefore making their narration more accurate and detailed. Moblogs can be seen as another type of probe, researchers can take advantage of this new promising way in which individuals can share their experience with the world. In particular, Moblogs could be use within the Experience Sampling Method, so that participants can post their information in narrative form to the Internet at indicated times with the use of mobile devices, providing the researcher with material in a relatively short period of time. Streaming video in real time or mobile video conferencing seems to be the next step in possible ways of capturing the user experiences remotely and in a more practical manner, without the need of the researcher to necessarily be present while the participant is performing his activity, and even maybe providing an alternative or a supplement to ethnographic methods. The foreseen advantages of this method just suggested for capturing the experience of drivers are many, and it would be interesting to explore its outcomes as soon as the technology becomes good enough to capture on video many of the details that surround the driving experience. In fact Consolvo and Walker [14], who have studied the ways in which the Experience Sampling Mehod can be used to evaluate ubiquitous computing applications, have also envisioned the use of new technologies for applying this method more effectively, for example with the use of wireless PDAs combined with digital cameras, with the drawback that the new technologies might make the participant to feel observed at all times. Perhaps the creation of augmented artefacts that gather and report usage information could be ways of capturing a user's experience. For example, cars could measure physiological responses from the driver, while recording the road with video in order to know the environment and context and the driver's voice with sound in order to know what he is thinking at those moments. The transmission of all that information could be automated so that it is received in a synchronized and preformatted way, making the life of the researcher easier when analysing it.

For the use of the Experience Sampling Method for this study the same questionnaire was answered by the participants in five occasions. It might be advised to researchers willing to apply this method to try to find the right questions to their questionnaires by trying them out in few volunteers before distributing them to their participants. Also, it could be a good idea to ask different questions every time the participant is signaled and maybe provide participants with small remunerations as a motivation to submit their answers.

From the applied methods we cannot say that there was a better one or a worst one. Although the one that worked the least was the postcards and maps probes, it is believed that it could have worked better with a slightly different approach. The Experience Sampling Method provided with more practical and straightforward data that could be analyzed more concisely. This method also addressed the issue of retrospective recollection of events involved in the blogs and in general participants reported to be entertained with the activity of having to answer some questions about their driving experience, since it was unusual and made them feel that something could be done to improve it. Unlike the ethnography observations, participants for the Experience Sampling Method did not feel intimidated by the presence of an observer, which could have provoked more truthful responses and more time to think about their answers. Moreover, the questions on this

method (see Section 4.3) did not asked the participants to plainly describe their emotions, but instead they try to guide them by asking how were they emotions influenced by certain factors. On the other hand, the participants of the talking-aloud-protocol were directly asked to describe their emotions as they drove and what caused them, which is a more difficult cognitive task, even more if they feel intimidated by someone observing them and listening to their responses.

4.4.2 Summary of the analysis of the results

The analysis of the results obtained from the different methods unveils some of the hidden meaning of the driving experience. Perhaps one of the most important things to notice is the relevance of the context in which the actions are taking place. Much like in many other activities, the activity of driving is very dependent upon its context, which was confirmed to be a moment-to-moment reaction to the actions of others, to the situations and to the overall organization of traffic. These characteristics are outside the driver's control, but exist because the driver experience them. Thus the driver's possibilities of action are somewhat dependent on and constrained by the context, in other words, by the possible presence, or absence of other drivers and road artefacts. The number of constrains and freedoms perceived by the driver not only dictates his actions but also his emotions towards the road in that particular instance of the activity; however, the driver is often unaccountable for his emotions, even when they are clearly expressed externally at times, hence suggesting that the driving experience from the driver's point of view is based not solely in his emotional state, but rather on the possibilities he has to act upon the road environment.

The returned results revealed many examples of drivers feeling limited by some aspect of the road, mostly by heavy traffic and the inability to flow through the streets, but also by other factors such as the failure to see properly in darken streets, or the helplessness to retaliate when other drivers got them mad. Also, the results express the feelings of satisfaction when drivers experience some sensation of freedom in their actions, like when traveling in an empty road in which they dictate their own speed or when they have a clear visibility. Such examples are situation when the driver expands his possibilities for action, which in turn tends to create positive feelings, therefore being perceived as a positive experience.

Another important observation is that drivers' experiences are relative. A driver judges his current experience based on experiences he has had in the past and even in the expectations of the possible experiences he could have in the current present or in his future experiences. The experience of a Formula One racer is much different than the experience of a 70 year old woman, which is different from the experience of a taxi driver. All of them could rate an instance of one of their driving experiences as *exciting*, however, what characterizes excitement in each of them is most likely to be very different from one another. What makes their experiences be different but to have the same label is the context in which it takes place as well as the relationship with the experiences that they have had in the past.

In conclusion, it is believed that, first, each of the methods could be improved to different degrees if the approaches taken were slightly different. The experience of applying the methods in the context of the road were good lessons on what to do, what not to do, and what to do differently. Second, the process of recruiting drivers as participants for the studies is crucial for the quality of the results. For example, for the talking-aloud-protocol it would have been better to selectively choose participants that like to talk, are outgoing and often unashamed of expressing themselves. Whilst for the Experience Sampling Method it was important to have participants who carry their mobiles at all times. In general, participants that are committed to the studies

are required and to increase their level of commitment personal contact and requests from the researchers to the participants is suggested. And third, the use of different methods served as good ways of complementing the information, having more robust material to be analyzed and account for the drawbacks that each of the methods presents.

From the application of these methods, and by looking at the cross-sectional results that they provided, four main factors were discovered, which were consistently expressed throughout the different methods by the different participants. These four found factors include *Light*, *Sound*, *Landscape* and *Interaction*, which will be presented in the following four chapters.

Chapter 5

On the Importance of Light

One of the objectives of this thesis was to uncover some of the prominent factors that constitute the emotional experience of drivers on the road. The research methodologies presented in the previous chapter provided the necessary evidence to discern some of those factors. The aspect of *Light* and the ways it is perceived by the road user, was found to be one of the influential factors that has the power of affecting the driver's emotions, and will be the first one to be discussed.

Kevin Lynch, in his book *The View from the Road* remarks the importance of the different light intensities that give a different aspect to the way a driver perceives the road [2], therefore probably influencing his emotions and driving experience as well. Some other studies have shown the importance of the amount of light as an influencing factor in the ongoing cognitive processes of an individual and its moods [60]. Although these studies do not necessarily explore the relationship between driving and lighting, it could be implied that these results can also be applied to a road environment. Driving during the day and during the night involves very different scenarios of the same activity, in which light is the differentiating factor.

Natural daylight is not the only factor that plays an important role on the driving experience. The driver is constantly bombarded by other sources of light that are commonly present on the context of the road, such as the lights emitted by the car and other drivers' vehicles, the lights produced inside the driver's own vehicle and mainly present on the dashboard and the roof, the public lights which illuminate the streets as well as the traffic lights, billboards, etc., the lights coming from building and houses along the road, and other lights which aid the driver navigate through the road in the darkness of the night.

The factor of light was regarded as important after the first few ethnographic observations of drivers and some of the pictures submitted to the gallery. After analyzing the results reported by the Experience Sampling Methodology we identified four main different categories related to light and its sources which are capable of influencing the driving experience either in a positive or negative way. These include:

- The amount of natural light that is perceived in a good way
- The amount of natural light that is perceived in a negative way
- The presence or absence of light coming from the vehicles
- The presence or absence of light coming from objects located on the road environment

5.1 Time of the Day

5.1.1 Daylight

Sunlight is essential for everyday life and has been proven to have several implications for people's general well-being and productivity at work and daily activities [65, 96]. Depending on the hemisphere and the time of the year, some cities can be illuminated by natural daylight more than others. Nordic countries such as Sweden or Canada are characterized by having only a few hours of daylight during the winter, while darkness only falls for a short period of time in their summer months. In countries nearer to the equator hours of daylight are more consistent throughout the year, as is the weather through the different seasons, making the amount of illumination of the road more persistent.

In the results obtained from the different methods there was a consistent positive response towards the presence of sunshine while driving. Regardless of their location, and of the proportion of sunlight they get during a year, people seem to appreciate the act of driving more when they travel under a sunny day with clear blue skies. Sunlight does not only bring positive emotions at the work place, as Leather et al. [65] imply, but also affects the mood of drivers traversing from one place to another. Positive response to sunshine while driving could be an obvious anticipation for drivers of, for example, Sweden, since the lack of natural light during the long dark winters makes people feel more attracted to this light whenever it is present. An unexpected result, however, is that people in countries where sunlight is common also prefer to drive under a sunny and lit environment.

Some relevant direct quotes obtained by the Experience Sampling Method (translated into English when necessary) corroborate this observation:

- *The sun, clear and bright makes me feel good*, (Mexico)
- *Good sight, nice weather, daylight*, (Sweden)
- *The light from the sun is pleasant at the moment*, (Mexico)
- *I love the sunrise, there is fewer cars than other days and I can appreciate better how the sun begins to illuminate the city. It gives me a sensation of well-being*, (Mexico)
- *The morning sun starts to clear and gives me a pleasant sensation*, (Mexico)

Data collected from the Picture Gallery also shows the positive response of drivers to some form of sunlight or nice weather with clear skies and luminous roads, as can be seen in pictures numbered 5, 7, 11, 12, 14, 20 and 24 from Table 5.1 (and more completely in the Appendix A.1), although some of these instances of pictures could also be related to the nice view of the road or the landscape at that particular point (discussed further in Chapter 7). As the comments on these pictures show, drivers usually refer to nice weather with bright natural light as being a positive influential factor to their driving experience. In this view, weather is somewhat related to the amount of natural light perceived during the day, and is thus also related to the driving experience.

Moreover, some of the weblogs present supporting evidence of people enjoying their driving activity when the day is lit and sunny, as can be seen in blog number 3: *'The sun was shining we were having a good laugh and singing along with the music'*, and blog number 6: *'Driving home*

Table 5.1: Some pictures of clear skies and luminous roads

Picture 5

Picture 7

Picture 11

Picture 12

Picture 14

Picture 20

from work this day, the sun broke through the clouds for the first time in about a week. There were beautiful shafts of light streaming down from the clouds', in Table C.1. Nevertheless it is known that excessive amount of sunlight might not be very welcomed in some parts of the world. In some African countries, for instance, people dread and dislike extreme sunny days, since this lead to unbearable amounts of heat that can become harmful for the car's engine and tires, and more importantly, for the drivers mood. However, it is important to recognize that, the factor of heat and weather in general is not the same as the factor of light and luminocity.

5.1.2 The Blinding Sun

Some responses where also received referring to the position of the sun and the time of day. At some occasions drivers reported the beauty of the sun while it was rising or setting and how that view and combination of colors in the sky created some kind of emotion, usually of a positive nature (see pictures 16, 23, 24 in Table A.1). However, the position of the sun can also affect the driver negatively depending on the direction in which the car is traveling when the driver is blinded by the light of the sun, impeding him to look clearly straight ahead or blocking the visibility through the rearview mirrors. This situation occurs usually in the early morning when the sun is rising or at some point in the late afternoon or evening before it starts setting, and is particularly reported by drivers as being 'annoying'. Thus, the positioning of the sun, depending on the time of the day and the coordinates at which the driver is traveling, play an important role in the emotional state, influencing also the way a driver maneuvers the vehicle and ultimately affecting the flow of traffic. The observations from the ethnographic methods show that when the driver is blinded by sunlight he tends to lower the speed of the vehicle, to wrinkle the forehead and eventually to use the roof's sunshade, but most importantly, there is an observable raise in tension or level of caution when the visibility is blocked by the sun.

In one instance, a driver was traveling in the E4 Swedish highway that connects the south of Sweden to its capital Stockholm. It was around 13:30 in the afternoon in late December and the driver was moving northeast towards Stockholm. At some point in the highway at that time of the

year and that hour of the day the sun sets exactly behind the vehicle, hitting the rear-view mirrors and impeding the driver to see anything that is happening behind him or to the sides. Even when it was not a particularly dangerous situation, since he had full frontal visibility and occurred only for a few moments, the driver lowered his speed as a precaution and expressed his worry at having the rearview mirrors disabled, making it very difficult for him to change lanes and being anxious at continuing in the high-speed lane, since he didn't know if there was a vehicle approaching faster wanting to use that lane.

In another example, captured by the Talk-aloud Protocol and presented on video (`http://www.youtube.comwatchv=AUWkKupjI9w`), the driver was traveling south from the city of Lund to the city of Malmö, Sweden, in the late afternoon of the month of March. At some point of the way the sun was setting in front of the driver who uttered "Now I am being bothered by the sun ... this is the worst hour to drive I think, when everybody is going home [from work]" and mentioned that the sunshade of the car was not helpful at that particular instant because of the angle of the sun.

Some other drivers also expressed their aggravation towards the blinding rays of light through the Experience Sampling Method ("The reflection of the sun can be bothersome and block visibility", in Table B.2 of the Appendix, the comments on the Picture Gallery (*'The sun is setting exactly behind the car, it hits the rearview mirrors and it becomes annoying and dangerous'* in picture 15 of A.1) and their writings through blogs (number 4 *'This was my first time driving solo since the time change, so fatigue and the sun blinding me made me unalert'* and number 5 *'I really dislike the spring change, which makes 5:00 drivers heading right into bright sunshine unguarded by clouds'* of Table C.1).

5.1.3 Night Driving

Driving during the night and during the day has different implications for the way a driver undertakes a journey. Although driving by night is much less frequent than daylight driving, around half of the overall car accidents occur during night time [75, 87]. Visibility of the road and its surroundings is obviously reduced when driving by night, and the driver's reaction time is also decreased by the reduction of illumination [3]. "The driver's eyes become adapted to the average reflection of the lights of the head lamps from objects both on and off the road" [3]. Night-time driving is related to accidents caused by fatigued drivers, or drivers feeling sleepy, drowsy and tired that loose control of the vehicle. The amount of light on the road at night is considerably reduced, making the driver bored and lethargic, specially when traveling long distances in non-urban areas [102].

Overall, drivers reported night driving as being harder, scarier, involving more tension, alertness and higher levels of concentration. According to a video report which cites a recent survey, lighting improvements "is the second most important innovation that consumers would like to see on their next vehicle" [71]. Perhaps with the introduction of Xenon Lights into newer cars the driver's worries and tensions of driving at night would be reduced, making him feel safer and more confident due to a greater area of visibility, not only frontal, but also partially illuminating the sides which allows the driver to be aware of oncoming pedestrians. However, it remains to be seen how annoying this type of lights become when used as high beams and are forgotten to be turned off when a driver is coming in the opposite direction.

One of the collected video logs depicts the experience of a group of friends traveling by car who for a moment cruise through a long dark segment of the road, which was captured on video and share on YouTube, and which seemed to produced in them feelings of fear, making them utter

with a tone of mixed amazement, excitement, nervousness and alarm “It’s dark out here...wow, you can barely see the road” (See *Driving Conversations* at `http://www.youtube.com/watch?v=lyr1Cj3bhds`)

5.2 Lights emitted by other Cars

Kevin Lynch states with certainty that “the lights of other vehicles indicate and enliven the road” [2]. The presence of other vehicles on the road at night is mostly manifested through its emitted lights. Even when traveling alone, the driver might feel accompanied by other few drivers around him, making him feel more secure and unworried. The lights of other cars provide a feeling of safety and also of companionship. The driver becomes aware that he is not the only user of the road, and has to be considerate of the other vehicles around him.

Break Lights and Blinkers

Other’s vehicles lights become increasingly important in a road which is not illuminated by lamp-posts, typical of rural roads or long highways. Also, in the presence of dense fog, mist and heavy rain that can further obstruct the driver’s visibility of the road and the only visible objects are the headlights of the cars in front, if any. On a darken road a driver can use these break lights of the cars in front as guidelines on where to go or the way the road is flowing. They can also serve as reference of the right lane to follow and as a moderator of the speed so that it is coordinated with the speed of others.

In one instance of the ethnographic shadowing method (`http://www.youtube.com/watch?v=jTztqdkWHBU`) the driver was a foreign male driving at night and for the first time in the streets of Sweden. The driver was an experienced driver and needed little or none instructions on how to drive in this country unfamiliar to him; however his speed, rhythm and direction were in part regulated by the cars around him. The use of the blinkers by the vehicle in front provided the driver with cues on how to steer the wheels and flow smoothly with traffic. The driver later reported his experience driving in a foreign country as been pleasant and quite relaxed, given that Sweden is a country filled with passive, ordered drivers.

In some of the interviews the drivers expressed their increase of alertness when realizing they were not alone on the road. This alertness is not necessarily negative, on the contrary, drivers feel more comfortable knowing that there are other drivers around when driving in the darkened roads.

The Headlights

It is common to experience a car driving on the opposite direction of a highway who forgets to turn off the high beams therefore making the affected driver complain about the oncoming car driving abilities and to flash back the headlights to make him realize his mistake with the hope that he will remember to turn them off. The same can happen with cars coming from behind, in which case the lights hit the rearview mirrors catching the attention and bothering the driver.

The responses from the participants of the different methods only show some reaction to the annoyance of having headlights flashed directly at them. In one instance of the Experience Sampling Method a driver traveling at night, who indicated feeling *Tired/Sleepy*, commented on

them saying "I am being bothered by the lights of other cars coming towards me". However, being blinded by the high beams of approaching vehicles is something that happens often and creates a momentary feeling of annoyance and stress in the driver, that can be classified in the *Activated UnPleasant* state.

Regardless of being annoying at times by other drivers, high-beam headlights are an essential aid for the visibility of the driver on a darken road, since low headlights do not provide the necessary amount of lighting for a confident driving and increase the amount of *overdriving*, or the proportion of lighting provided by the headlights relative to the speed the car is traveling at.

5.3 Lights from the Road

The most obvious type of light coming from the road is the light emitted by the light posts at night, however it is not the only one. In urban areas the streets are illuminated also by the light coming from inside buildings, stores, houses, billboards, decorations, etc. For this study the important thing to consider is how those light affect the driving experience.

Temporary Decorative Lights

From the collected ethnographic observations and weblog material, participants driving in different streets of Sweden at night showed their awe towards the Christmas decorations that are a typical tradition in cities throughout Sweden and Norh America. The presence of decorative lightings on the road seems to provoke positive feelings in the driver, particularly those of delight, amazement, calmness and content. These feelings are probably due to the momentary presence of light that changes the aspect of the road and fills it with another tone of luminosity, creating a special atmosphere and evoking pleasant feelings in the driver. If the lights were not to be removed and presented all year long, the shift of emotions would most likely not exist, since is the change of the appearance of the road that creates the atmosphere. However, this remains to be proven.

In one of the presented videos the driver was traveling through the streets of Helsinborg in Sweden, a city which was beautifully adorned in the month of December of 2006, and which impressed the passengers and the driver who reduced the speed and shifted his attention from the road to the lights on the trees. From video logs, we encountered a couple of drivers who considered the Christmas decorative lights as beautiful and expressed their happiness while looking at them. In fact, some people just go out for car drivers at night to catch a glimpse of the decorative lights located around the city.

Traffic Lights

Traffic lights can be categorized as traffic objects, nevertheless, they are a source of light that comes from the road and which is able to influence the emotions of drivers. In several occasions participants mentioned traffic lights in one way or another, usually to refer to them as annoying when they have to wait for them for a long time to turn green. In some countries traffic lights enforce more power than in others. Respondents of Mexico often expressed their desired to run by the lights, especially when no traffic police was around and when there were only a few cars coming on the perpendicular direction, and in fact, they usually do cross them in many situations. Drivers from Sweden on the other hand mention their annoyance that the waiting produces, but the idea of crossing a red traffic light doesn't usually cross their mind (see Figure 5.1).

In general, traffic lights are perhaps the most common traffic object that constantly catches the attention of the driver. They have the power of making the driver aware of his activity by

bringing to his center of attention the speed at which he is traveling and making him conscious of the presence or absence of others. The feelings of annoyance they tend to produce comes from the frequent disruption of motion and speed experienced by the driver, and from being forced to *wait*, which seems to be a dreadful punishment for most drivers, who need to move and arrive on time to their destinations.

Figure 5.1: *'I was annoyed because we had to wait so long for the traffic light to turn green, specially because there were no other cars coming on the other direction'*

However, traffic lights also allow the driver for a momentary pause from the activity. Drivers or passengers often take advantage of this short break to engage in some other smaller activity within their car, like changing the radio station, looking for directions on a map, adjusting their rearview mirrors, searching for lost objects or even dialing phone numbers. It also allows them to look at their surroundings, which, besides the landscapes or buildings, also include the other cars around. At times, it seems that drivers possess an innate curiosity of looking into other people's car while they wait in a traffic light, and being stopped at a traffic light also gives the opportunity of eye contact with other road users.

In one of the trials for the shadow method, a foreign driver showed his amazement towards the difference in the sequence of colors between traffic lights in his country of Spain and traffic lights in Sweden. In Spain lights change from *green* to *amber* to *red* and then straight to *green* again, whereas in Sweden they go from *red* then to *amber* and to *green*. However, traffic lights everywhere serve the purpose of regulating traffic, and they do an efficient job at it. The existent complaint of drivers on having to stop and wait at the traffic lights to be green would be nothing compared to the complaints they would make by the chaos that would be created if there were no traffic lights whatsoever.

Chapter 6

On the Importance of Sound

Another factor found to be relevant for the emotional experience of driving is the many sounds encountered on the road. The sense of hearing is an essential indicator of our surroundings. It alerts us of the happenings in the immediate environment which we cannot directly attend to visually. Thanks to the hearing sense we can have cues of the actions occurring behind our backs, as well as fabricate clearer mental models of what our eyes are capturing. Different sounds are an unavoidable part of our environment, which can vary from beautiful melodies to disturbing noises. Different sounds are also constantly been perceived by our auditory system, which has the task of arranging these muddling sound streams and transforming them into perceivable events. Our brains are capable of untangling the bombardment of sounds from the different auditory sources and recognize their amplitudes, their proximity of occurrence, harmonicity, synchronicity, etc. [23]. Even though many people take it for granted, the hearing sense plays a crucial role in our daily activities; without the sense of hearing, or sounds to stimulate it, we could experience a feeling of seclusion from the world around us, we could appear to be isolated from the company of other people, and clueless and unaware of some events taking place in the proximity.

Several research works have shown the relationships of sounds, mostly musical sounds, and the emotions these sounds are capable of eliciting. Dr. Manfred Clynes is an Australian researcher and musician who has studies the way sounds and music affect a person's emotions. His research has lead to his Sentic Theories, which is the study of the relationships between pressure waves and emotions [11]. Clynes argues that emotions are coded into the human's nervous system and they are elicited by specific external triggers, emotions are prompted with greater ease and pureness depending on how well the trigger *fits*. Since music and other sounds elicit emotional responses in users, the clearer these emotions are felt the better the sound which elicits them is [117]. His theories are now used by practitioners of alternative medicine who believe on the power of music and its healing effects. An important aspect to consider is the reaffirmation that the reception and process of elicitors of emotions are very subjective to each individual and his or her experience. Not everyone reacts the same to the same sounds, some people cannot stand the scratchy sound of nails on a blackboard while others do not mind it, and some people prefer listening to classical music while others enjoy heavy metal.

The factor of sound came first to the attention of this study after noticing that drivers can change their emotional states as they experience different sounds along their journey. They can get stimulated, excited and melancholic by the rhythms of different musical tunes coming from within the car's stereo or annoyed, distressed and anxious from all the surrounding noises they can perceive. Toyota's innovative car, the POD, which was manufactured with the concept of emotions in mind [125], is concerned with providing the user with a rich sound experience, which

is a reaffirmation of the importance of sound when trying to capture the driver's emotions. The driver is constantly surrounded by a different mixture of sounds from the beginning until the end of his journey. These sounds could be made of different pitches, tunes, rhythms, noises, etc., and can be produced by different sources. For the purpose of this discussion, a *sound* is understood as any possible note that is able to stimulate the driver's auditory system, therefore ranging from the music emitted by the car's stereo to the noises of the car's motor and the engine of other vehicles around the driver.

Surrounding sounds are very indicative of the actions of nearby others taking place at particular moments. Its continuous input provides the road user with constant awareness about other people's activities as well as his own. We can easily picture a scenario where a driver chooses to close his eyes while maneuvering the car, therefore depriving himself of the essential visual input that leads him to the streets, and conclude with a high level of certainty the likeliness of a major catastrophe to occur. However, it is not that common, in fact almost never, when we imagine a driver purposely plugging his ears in order to be dispossessed from his hearing abilities while on the road. Obviously, the likelihood of provoking an accident would be much less for a deaf person than a blind individual, but the environmental cues provided in the form of sound while driving shouldn't be taken for granted. Leaving the importance of *sound* out of a discussion on traffic flow would be irresponsible and incomplete, since sounds are a crucial factor that influences the driver's experience, the way drivers interact with the road and with each other, and therefore ultimately affecting the flow of traffic.

6.1 Types of Sounds

A distinction can be made between the different perceived sounds on the road. There are sounds that are constantly there; they are usually contained within the vehicle and continuously picked out by the driver's auditory system as he goes through the streets until his final destination. There are other sounds that are momentarily perceived; they are heard for small or long instants, in particular situations at a particular segment of the road or of the journey. They are not permanently heard, since they are usually, but not always, generated by the road, therefore leaving the sound behind as the vehicle continues its forward motion. Momentary sounds created within the vehicle, traveling with the driver for some moments to eventually disappear, also exist and are quite common.

In the results of the Experience Sampling Method participants referred to some sounds that affected their driving experience, which can be classified into four main categories in relation to their sources, and were recoded accordingly in Table B.4. These categories include:

- Sounds coming from the driver's own vehicle
- Sounds made by other nearby vehicles
- Sounds coming from other nearby road users other than the vehicle itself
- Sounds from the external environment nor related to the vehicles

6.1.1 Own Vehicle's Sounds

The Power of Music

One example of a type of sound that accompanies the driver and other passengers of the car throughout their journey is the music played by the installed stereo. This type of sound could fall under the pleasant sounds category, since drivers are willingly listening to it, have the freedom to change the melodies and the choice of turn it off completely if it becomes annoying or distracting. Listening to music while driving is perhaps one of the greatest sound determinants which are capable of influencing the driver's current state of mind, therefore being crucial for determining a person's overall driving experience.

Music has the powerful property of being able to trigger certain emotions on people and alter core-affect in mysterious, rich ways, not only on drivers, of course, but in everyone able to listen to it [117]. Some songs could push the driver down to the deep sorrows of melancholic or nostalgic feelings while others can provoke momentary states of euphoria and inexplicable happiness. However, the emotional displays created by musical sounds are momentary and very subjective, being perceived differently by different individuals. The same song can fill one person with joy and another person with complete repulsion.

An interesting characteristic of music melodies is their capability of making their listeners to vividly remember previous relevant episodes of their lives and recall emotionally lived experiences; a previous love might be reminded by a certain song, or last year's summer holidays might be brought to life when an old tune is suddenly played. In other words, "the emotion created by a piece of music may be affected by memories associated with the piece, by the environment it is being played in, by the mood of the person listening and their personality, by the culture they were brought up in: by any number of factors both impossible to control and impossible to quantify. Under such circumstances, it is extremely difficult to deduce what intrinsic quality of the music, if any, created a specific emotional response in the listener" [115]. Nevertheless, and however subjective an experience might be, it is generally, but arguably, the case in which sad, slow rhythms might usually trigger feelings of sadness, peacefulness or relaxation, whereas highly pitched songs with strong basses' and drums' sounds exalt individuals and make them follow the rhythm by dancing or moving their body parts. Interestingly enough, it is often the case when there is a certain appeal of feeling nostalgic or sad, and people purposely listen to songs that would cause them to feel those emotions. From the observations made using ethnographic techniques, it was possible to corroborate that the music coming from the car's stereo can play an important role on the way the driver handles the vehicle, the speed at which he travels and the mood he will be in.

Scientists, such as Carol Krumhansl, have studied some of the effects music has on the brain and therefore on the way humans could coordinate their movements and be emotionally influenced by those sounds. She concluded that "music with a quick tempo in a major key [...] brought about all the physical changes associated with happiness in listeners. In contrast, a slow tempo and minor key led to sadness" [68]. This finding has important implications in the study of drivers' experiences on the road, and it was somewhat confirmed by the ethnographic observations made of drivers maneuvering a vehicle through the highways and streets of Sweden. During these observations a direct correlation between the music been played and the driver's driving patterns were noticeable and obvious. Popular music characterized by high notes and *catchy* rhythms tends to excite the driver. His position on the seat and posture whilst handling the steering wheel also change, becoming somewhat stronger and having more grip on the object, while at the same time trying to make an impression of *coolness* but being naturally joyful. In some occasions the passengers and the driver himself exclaimed the desired of enjoying that music in an explicit form

by saying “I want to dance now...”. In some other occasions the drivers expressed their feelings of relaxation, calmness and joy due to the type of music. Observing these patterns of the driver behaviour and interpreting them with their relation to the felt emotions has an important value over simply questioning the drivers about their attitudes and feelings while they operate the vehicle, since it is commonly known that what people are able to describe in words and what they are actually experiencing in real life do not necessarily match. Which was one of the advantages of the shadow method over the talk-aloud-protocol or the Experience Sampling Method.

Inescapable Sounds

An inescapable noise that follows the driver is that of his own vehicle’s engine and tires. This type of sounds was not reported explicitly by the participants of the different studies as a major factor that was capable of influencing their emotions, the reason being that the permanent characteristic of these types of sounds moves out of the driver’s focus of attention and is perceived as white noise which the driver gets accustomed to, passing unnoticed until it is stopped.

Intuitively, it could be argued that this type of sounds can be obvious stressors or can have negative effects on emotions. However, that is not always the case, since for some drivers the roar of the engine and the braking tires gives them a thrill, excites them and makes them feel powerful or in control, as seen in one participant’s response to a question in the Experience Sampling Method: ‘When I hear the engine, it makes me feel I’m going faster, then I start accelerating and I find myself at high speed a while later’ (see Table B.3).

Nevertheless the videos capturing the actions of people driving (some of which are presented at `www.youtube.com/group/emotionalroad`) show the amount of noise generated by the motor and by the friction of the tires with the pavement. The videos corroborate the fact that the quality of the car is very important for reducing the noise perceived inside the car [24]. During the ethnographic observations of participants driving, two different types of cars were used, a *Volvo V50* and a *Ford Ka*, the former is a luxurious type of car, in which the noise of the tires and the engine was not a major issue. The inside was well isolated from the external noise, which allowed for normal conversations, normal music volume and an observable more relaxed and smooth driving experience. On the other hand, on the sessions where the Ford Ka was driven by participants a considerable amount of noise was noticed inside the car, coming from the engine, the pavement and the wind drag, which impeded the passengers to communicate normally. In one occasion a participant chose to drive on the highway leading from Lund to Helsinborg in a Ford Ka with four other passengers, including the observing researcher. The journey was mostly silent, possibly due to the effort the passengers had to make in order to talk and be able to hear each other. Critics of the Ford Ka, agree that “during long journeys the engine and road noise can become bothersome” [8]. Participants who drove this car also observed and commented on its speed and stability which accounted for their driving experience, but which will be discussed in another section.

From the submitted photographs and comments on the picture gallery (Table A.1), the participant on picture 23 comments on the noise created inside the car due to the wind coming from the window, which prevented the passengers from hearing each other. The categorized emotion for this particular picture in relation to Russell’s Circumplex was *UnActivated UnPleasant*, which corroborates the idea that noise provoked by the drivers vehicle does not have a positive influence on emotion.

For this reason, car manufacturers are looking into creating more soundproof vehicles for the comfort of the drivers [24]. Reducing the noise perceived inside the car is not an impossibility but which depends on the material and cost of the car. Yet, car manufactures would be providing

their drivers with a much greater emotional experience if they give them the option to shut down those inescapable sounds with which they travel at all times.

6.1.2 Other Vehicle's Sounds

On the other hand, a driver could escape, in theory, from the noises produced by other vehicles if he rolls up the window and drives away from them or decides to follow a path free of noisy vehicles; however, this is hard to accomplish in practice most of the times. From the returned material of the different used methodologies, we can accurately say that the sounds, or rather noises, coming from the other vehicles surrounding the driver have certainly negative connotations on a person's emotions while driving. The responses of participants constantly corroborate their annoyance towards the loud sounds made by others' vehicles. In the best of cases, some participants indicated that the noise from other cars kept them alert and impede them from falling asleep, but none said that this type of noises generated any kind of positive feelings in them.

In particular, subjects of the different methodologies continuously referred to the following sounds coming from other vehicles as the main perceived sounds capable of influencing their emotions:

- Honking the car's horn
- The engine from other vehicles, specially trucks
- The siren of ambulances and police cars
- The sound of tires braking

All of these sounds involve high decibel levels which get into the nerves of any road user. Their audibility indicates the presence of others and makes them momentarily aware of their driving activity. A car's honk and the sirens from police cars or ambulances are sounds that are intended to purposely call the attention of the driver. They serve as simple mediums of communications between vehicles, and even when the intention of their existence is benevolent and has the purpose of helping road users their excessive use can cause extreme irritation.

The sounds from braking tires indicate the rapid attempt of some nearby driver to brake abruptly in order to prevent an accident. This type of sound is mostly involuntary and it is easily recognized by the road users, creating feelings of alertness, curiosity, worry and momentary tension.

When a honking sound is heard the driver tends to become aware of his actions and his context, in order to check if the sound was directed to him and fix his perhaps unintended error, such as changing lanes with high risk of hitting another car, being unaware of the traffic light changing green, breaking abruptly for no serious reason, etc. The activity of honking, besides producing a noticeable sound, it is a form of interaction, and is discussed further in Section 8.2.3.

6.1.3 Sounds from the External Environment

A silent road is rarely encountered. The roads and streets are usually filled with noises, mostly produced by the cars on them, but also by other road users and objects around them. Even in

the rare occasion when a driver finds himself traveling with no other vehicles nearby, he still can listen to the sounds produced by the road and its other users, which include, but are not limited to, sounds from the markets and commerce, noises from construction work, voices of pedestrians, sounds from animals and trees, the sound made by rain, thunder and wind, noises from aircraft, etc. Some of these sounds are perceived only momentarily, while others travel with the driver for longer periods of time, such as wind and rain.

The sounds from other road users and from the external environment are perhaps not necessary for the activity of driving, but enrich the driving experience in many different ways. Without them the driver would experience the same effect of driving through a tunnel, were only those sounds from other vehicles and the driver's own vehicle would be perceived. Unfortunately, most of this sounds coming from the external environment are seen as unpleasant noises, except for some of the noises of nature, such as the water in rivers or the chirping of birds. Others just passed unnoticed, like the sounds of bicycles, skaters and merchants. And all of these are usually perceived faintly, since they are overridden by all the other noises sourcing from the surrounding vehicles. The important thing to notice is that the driver does not have any control over these kinds of noises, except perhaps by closing his window to try to diminish them.

6.2 Conclusions

General conclusions on the factor of *sounds* can be observed in the returned results from the Experience Sampling Method (see Table B.3). The answers from participants seem to indicate that sounds produced by vehicles in general and sounds produced by other road users have a bad influence on emotions, whereas listening to music while driving and sounds coming from the an external environment other than the road *per se* have a positive influence on the driver's emotion. The following crosstabulation shown in Table 6.1 shows a summary of the coded results (see Table B.4) for the total of 27 participants.

Table 6.1: Crosstabulation of sound sources and their influence on emotion

		Sound Influence on Emotion			Total
		Bad Influence	Good Influence	No Influence	
Sound_Factors	N/A	0	1	5	6
	External Environment	0	3	0	3
	Music / Radio	0	4	0	4
	Other Vehicle's Sounds	6	2	0	8
	Road Users	2	0	0	2
	Vehicle Sounds	3	1	0	4
Total		11	11	5	27

This crosstabulation analyzes the interrelation between the sound influences on emotion and the sources which emitted the sounds. The table indicates that there was the same amount of respondents who were influenced negatively or positively by some kind of sound as they were driving, whereas in five occasions participants considered that sounds where not influencing their emotional states while they were driving. The sounds that are most noticeable for the drivers are those sounds produced by other nearby vehicles on the road; notice that sounds produced by the driver's own vehicle are also substantial if we considered *Music/Radio* and *Vehicle Sounds* as coming from the same source, the driver's own vehicle. Surprisingly, participants didn't report any music or sounds coming from the external environment other than the road as being negatively

affecting their emotions at that given moment. Contrary to the expectations, the majority of people said that they were not listening to music or the radio while they were traveling and answering the questionnaire for the Emotional Sampling Method. This is different from the ethnographic observations, such as the shadow method, where the drivers' tendency was to have the car stereo turned on most of their journey. Moreover, having music that the driver enjoys seemed to have a great influence in the individual's driving patterns.

Chapter 7

On the Importance of Landscapes and Architectures

Besides light and sound, another important factor discovered by the results returned from the applied methods, was the relevance of what is visually accessible to the driver while he travels, which are usually landscapes, sceneries, and architectural buildings.

Kevin Lynch tried to study the way people perceived the architecture and layout of their city. He looked at ways in which the design of the road would affect the awareness of its users and suggested the blending of roads into the landscape, considering primarily the experience and enjoyment of the driver without necessarily disrupting the flow of traffic on the process of their design [2]. In other words, Lynch was concerned with the design of roads and highways that would create a pleasant *highway experience* by augmenting its features of motion, space and view.

7.1 The View of Landscapes and Architectures

When talking about the road, it is almost necessary to mention its visual surroundings, i.e. its landscapes, sceneries, buildings, views, etc. A road without view would just be a tunnel, in which the drivers have little or none external visual stimuli to provoke their inner feelings and diminish their sense of motion. The road has an almost necessarily embedded feature of a view, the physical characteristics of a vehicle surrounded by windows allows, and almost forces its passengers to look to the outside. Thus the melting of the road into its landscapes, as suggested by Lynch [2], would perhaps provide with a more intense positive experience for those inside and outside the vehicle.

Motion pictures are known and liked for their capability of inciting deep emotions on their viewers. They do so solely through the use of visual continuity sometimes mixed with music and other sound effects. A spectator at a movie theatre would sit inside a black room in front of a big screen and perhaps be emotionally moved by the images and sounds displayed, and which are the only two elements that constitute the movie-experience. Similarly, the driving experience endows the driver with constant visual stimuli through the vehicle's windshield (analog to the screen in a movie theatre) and continuous sounds, but unlike a spectator in a movie theater a driver is able to also perceive feelings of touch, motion, space and even smell at times, as well

as sense his surrounding's rich environment through his periphery. However, drivers are hardly ever more conscious about their actual emotions than a person watching a movie. Perhaps this is due to the fact that drivers are more preoccupied with the actual action of driving, which is a complicated activity involving high levels of attention, whereas movie watchers focus all their attention in the screen, having few other distractions to consume them. Another explanation, more relevant for this discussion, is that the road does not provide its viewer as interesting and varied sequences of *scenes* as those presented in a regular movie. The observed landscapes and sceneries can provide the driver with momentary amusement, episodic awe and a sense of flow, but those same views are likely to become monotonous if presented continuously and repeatedly, therefore unfettering the attention of the driver. It is in a city environment, rather than in a country highway, where the mind of the driver is mostly focused on the road and its surrounding architecture, whereas long prolonged roads give the driver's mind the opportunity to disperse into other thoughts and worries. A driver cruising through an unfamiliar city or unusual streets will tend to gaze at its architecture or surrounding road users if these happen to be of enough interest. The driver could then express his feelings of amazement or delight towards attractive or interesting objects on the road, such as unusual buildings, decorative adornments, historical places, etc., or he could show disagreement, disappointment or annoyance if unpleasant things are encountered, such as dirtiness on the street, vandalism, rundown buildings, neglected road objects, etc. In contrast, the landscapes and architectures tend to become *invisible* to a driver that is very familiar with his path and crosses it with regular frequency [81]. New forms of capturing the attention of the driver are needed in order for him to reaffirm those feelings of amazement and confirm that road watching is actually a delight [2]. Continuing with the analogy of a movie, watching a movie through a big screen might have more effect on emotions than watching the road through a windshield due to the fact that movies usually have a plot consisting of a beginning, a climax, and a conclusion, whereas a regular car trip usually consists of only the beginning and the end with a somewhat monotonous activity in the middle that rarely has a high spot or any kind of plot to amuse the voyager's journey. Occasionally a driver might encounter unusual events or objects along the road which will make that driving experience different from the previous ones and excite his emotions in some way, but most frequently the activity of driving might seem ordinary to the driver who frequents the same routes, just as watching the same movie over and over again, which eventually brings no surprises and the emotions it used to produce, if any, slowly fade away. However, this jadedness of visual perception might not always be necessarily true; for example, some people reported choosing their daily route to their destination based on the beauty of the trees located along some streets, which in turn created in them feelings of tranquility and well-being, even when the trees' scenery did not change over long periods of time (Figure 7.1). What is more, the constant and inevitable interaction with other drivers is what makes the driving experience dynamic, varied and lively, and what could introduce the *climax* into the plot of a driver's journey. It is these and other forms of interactions on the road that the next chapter, Chapter 8 is concerned about and will try to explore further.

Figure 7.1: *'An avenue surrounded by trees,... they create a peaceful atmosphere, making you feel like you're going through a natural tunnel'*

7.1.1 Appreciation and Depreciation of the Scenery

In the series of experiments done for this thesis, the aspect of landscapes and its relationship to the emotion of drivers was very tied together. Repeatedly, participants refer to the looks of the road and how it influenced their emotional states. Recall that respondents in the various methodologies

were specifically instructed to not comment upon the visual *looks* of the surroundings while traveling by car, but rather they were asked to comment on their changes or provocation of feelings and emotions, if any, from what they perceived through their senses. This left us with various interesting responses and useful data related to the alteration of the drivers' emotions depending on what they could visually perceive from inside the car, ranging from their feelings of calmness and easiness while looking at the rising sun, the flower decorations, the greenness of the prairies, the colors of the sky, etc. to their sensation of anger and frustration in response to the ugly billboards, graffiti, and other unpleasant objects that alter the visual aspect of the city and the road's scenery.

Some evidence of these findings is presented on the picture gallery, Table A.1. In picture nine (Figure 7.2), for instance, the participant refers to the flowers on the side of the road as bringing feelings of happiness, and being categorized into the *Pleasant* section of the circumplex in Figure 3.3. Some studies have actually shown that flowers are inducers of positive emotions [37], and designing roads adorned with flower arrangements could be beneficial for having a pleasant driving experience. The participant in picture 20 also refers to the niceness of the landscape in Sweden, and was perceived as falling on the *UnActivated Pleasant* category. Picture thirty-two depicts the nice view that can be perceived in a highway through the mountains and away from the city, whose owner commented on the feelings of well-being that such view produced in her. The participant on picture thirty-one shows a city avenue filled with tall green trees, which makes her *'feel connected with nature'*.

Figure 7.2: *'The flowers made the sides of the road very nice. There were flowers everywhere... They made me feel happy...!'*

Figure 7.3: *'Everybody has the right to show their ideas and preferences, but I don't like this kind of expression in my own city, I feel invaded in my own thoughts'*

On the other hand, picture thirty (Figure 7.3) shows an apparent public manifestation, vandalism or a strike, and the owner of the picture expresses her dislike towards that kind of images in the city, making her emotions at that particular moment fall under the *Activated UnPleasant* group. Notice that the comments of the participants in the picture gallery do not focus on the visual aspect of the pictures, but rather on the effect those visually perceived looks had on their emotions. Pictures that had no relevant comments on the actual felt emotions and only described their contents were disregarded and not included on Table A.1.

From the Experience Sampling Method (Table B.2), several participants expressed their discontent towards damage made to their city's architectures by saying *'The deterioration of the looks exposed on the road makes you wonder why are they so bad, and makes you feel frustrated and sad'* (self-reported affect was *Activated UnPleasant*), or *'So many billboards get me nervous and make me angry'* (self-reported affect was *Low Activation*), in fact, studies at the University of North Carolina has shown the effects of billboard advertising on driving [108]. On the other hand, participants also showed their appreciation of nice-looking landscapes by writing things like *'Flowers are blooming, spring is soon coming'*

(self-reported affect was *UnActivated Pleasant*), or *'I am driving through a zone of nice sidewalks and trees along the road that I like and always makes me enthusiastic'* (self-reported affect was *Activated Pleasant*). Another participant, originally from Sweden, captured through video a moment of her experienced on the roads of Mexico City, her major impression as she discussed it was the lost of concentration due to the quantity of billboards, which make the city look unpleasant and eventually become bothersome.

In general, it is fair to say that drivers value the appearances of the road's surroundings. They appreciate attractive elements positioned along the road, even if they can perceived them for just an instant, since they will continue onward with their journey and leave the scenery behind as they pass it. Some elements of the road's landscape can have obvious positive or negative connotations on emotions, while others might produce mix feelings or be irrelevant and passed unnoticed.

7.1.2 Personal Attachments to Road Segments

The architectures along the road and its places also provide an uncommon characteristic. It was frequently declared by drivers and road users their individual attachments or affections for particular buildings or places along the road on which they travel on specific occasions. Driving through specific places, mostly previously visited or recognized by the driver, can bring back memories of previous occurrences, dear persons or special moments in the driver's life. Driving through a particular church, for example, could remind the driver of her wedding day which took place on that precise church, and provoke some emotions. The same could occur when driving through some restaurant which could bring back memories of the fun times the driver used to have there with her friends.

For instance, picture number four of the table presenting the picture gallery (Table A.1) shows an example of how the participant felt connected to that building, with a characteristic architecture of old European cities, which made her feel nostalgic since it reminded her of her European origins. In another picture, number 16, the respondent stated how the planes located along the Swedish highway near the city of Linköping reminded him of someone, making him feel nostalgic, but happy at the memory of his friend. Picture 25 depicts a sign of the road located in the streets of Detroit, which the foreign driver recognized as being related to a motion picture, and making him cheerful and glad at having encountered it. From the interviews and discussions a lady respondent mentioned with reference to a photograph how one of the road's sideways filled with peculiar trees which she usually traverses always reminds her of a beautiful day spent with the man she loves. In another photograph, a person shows his university's faculty building, which can be visually located from the adjacent road, and comments on how it brings him back happy memories of the years he studied there and how he identifies as a member of that faculty.

Table 7.1: Examples of segments that emotionally attach the driver to the road

Picture 4

Picture 16

Picture 25

From the encountered weblogs, a blogger expressed his recollection of memories of his youth

and own hometown while driving through the town of Mobile, Alabama and looking from the road at a nearby skyscraper: "Mobile's skyscrapers are particularly interesting ... One reminds me of a big slide shaped like a rocketship that used to be in a park near my home growing up" (see numer 01 of Table C.1).

In conclusion, there is enough evidence to believe that the driver can have a personal attachment to certain places and segments of the road encountered along his journey which are capable of triggering memories, which in turn trigger the corresponding emotions connected to those memories. Section 2.3.1 presented the cognitive perspective in relation to the study of context, which can serve as an explanation for the tendency of road users to externalize value into road objects and road segments (these being buildings, public places, monuments, adornments, etc.). Hollands and Hutchins [40] tried to demonstrate how the interaction with external objects can be internalized cognitively by an individual, creating an emotional attachment triggered by the memory of its previous contact. Cognitivists argue that objects are augmented with knowledge and information, for example, a particular building along the road can convey its information to the driver in the sense that the driver recalls personalized relevant events that previously took place on that building or are connected to it in some way. Thus, from a cognitive theorist point of view, it comes as no surprise that the emotions of drivers can raise from visually locating physical objects along road segments.

7.2 The Feeling of Motion and Space

Lynch asserted to recognize the feelings of motion and the perception of space inherited on the activity of driving. These two factors, he correctly claims, are always intertwined, since the constant feeling of one's forward motion is based on the visual perception of the space outside the car, without the sense of vision the driver is hardly able to distinguish his motion and traveling velocity [2]. The passing landscape and sceneries through which a driver travels provide that sensation of moving forward and the feeling of eventually reaching the desired destination. Is this reason, perhaps, that the event of being stuck in traffic results in frustration and anger from a driver, since it does not provide him with the feeling of ever achieving the end of his journey. Kevin Lynch also states that the "*The sense of varied motion is inherently enjoyable if continuous and not too violent*" [2], which implies the pleasurable emotions felt by passengers of a car when taking sharp curves or steep angles, providing lively feelings of excitement and a momentarily pleasant road experience due to the topography of the road.

Unexpected or clumsy movements of other vehicles may have a negative effect on the driver's emotions. Drivers tend to complain on the ability of others to drive when the opportunity is presented and judge their own driving actions as flawless. Sudden braking from the car in front, for example, is a common complain and an obvious stressor, occurring frequently in big cities with high levels of traffic.

7.2.1 Feelings from Spatial Perceptions

Lynch's view of space referred to the perception of the degree of visual or physical openness in which the road user is free to displace, i.e. Lynch analyzed the spatiality of the road from the point of view of its constraining walls on the sides, ceilings on tunnels, and the wideness or narrowness of the pavement, but failed to provide information on the effect that other vehicles have on the driver's perception of the amount of space.

From the gathered data, the general conclusion is that openness tends to elicit positive feelings on the driver. By *openness* we refer to the visual perception of the absence of constraining physical objects of the road, such as mountains, high buildings, narrow streets, etc., but also, and perhaps more relevant for the discussion of this thesis, *openness* implies a road free of impeding vehicles. The event of the lack of cars on the road the driver was traversing was constantly reported by participants as giving a sensation of *freedom* and *excitement* at the possibility of moving faster (e.g. *'It excites me that I can go faster now that the city is almost empty'* from Table B.3). From the pictures and their comments presented in Table A.1, pictures 1, 12, 13, 20 illustrate this sensation of open space and most of them can be interpreted as falling on the right side of the circumplex (see Figure 3.3). On the other hand, notice how pictures 27 and 28 shows a great number of cars or road users surrounding the driver, creating a feeling of being enclosed and his emotion being interpreted as UnPleasant from his picture and comment. Notice how the picture representing openness were mostly taken on the roads of Sweden, characterized by few and calm drivers, with long and steadily designed roads, while the enclose feelings occur mostly in the streets of Mexico City, a completely different environment characterized by the exaggerated excess of vehicles.

In one of the Video Logs a driver shows his experience driving a motorcycle through the streets of Hawaii. From his posted video (see *Driving in the Blind Spot* video at `http://www.youtube.com/group/emotionalroad`) one can observe the amount of cars at times which produce a feeling of confinement, but the lack of vehicles at other times allow the driver to flow at ease through the streets. The driver mentions how the houses, buildings and cars, which constrains the space, can block visibility of oncoming cars on the perpendicular direction, which causes the driver to move their heads back and forward to watch for oncoming traffic at the intersection on this city.

While the levels of openness perceived by the drivers usually has a positive impact on their feelings, these kinds of nice-looking, open, relaxing highways are not always benevolent, since they can induce jadedness on the driver overtime and gradual boredom and sleepiness, situating a driver into the *UnActivated UnPleasant* category of Larsen's Circumplex. The lack of cars in the proximity and the sensation of ample space can make the driver over-relaxed and not alert. This fact might be actually have a relationship with the level of traffic on the highways, which might allow the driver to pay more attention to the scenery and focus less on his interactions with other drivers. Lynch recognizes that traveling on long, constant highways with abundance of perceived space and repeated sceneries can "induce sleep, frustration or excessive speed, simply because of this long-continued visual torpor, this apparent inability to reach a goal" [2].

For these reasons, a moderate level of traffic could be even considered beneficial, since it alerts the driver, makes him feel accompanied, providing him with a sensation of flow, and also permits him to engage on certain levels of unintended interaction with neighboring others, a topic that will be discussed in the following chapter.

Chapter 8

On Drivers Interaction

The fourth discovered factor, and perhaps the most important one, is the interaction that takes place on the roads. Unlike subway drivers, for example, who in past years had very limited ways of communicating with train controllers, train passengers, and the rest of the world outside the train [38], car drivers have many distinct ways to collaborate directly and indirectly with others, such as passengers, other car drivers, pedestrians, etc., even when they are sometimes traveling alone, and always isolated by the containing metals of the car.

As previously mentioned, drivers on the road are constantly interacting with one another. Oskar Juhlin is one of the researchers who has realized the importance and detailed moment-to-moment actions of the driving activity, by stating that

> Road use is understood as a cooperative activity, since a number of actors share a common resource (the road) and through its use change the conditions and possibilities for other users. They are force to show consideration, or at least adapt their activities to each other, that is to coordinate them, in order to avoid accidents and disturbances [51].

As mentioned on Chapter 2, Mattias Östergren has conceived the term *Traffic-encounter interactions* to name those interactions occurring on the streets, or "the mundane social practice all drivers must engage in when coordinating movement with other co-present drivers" [80]. In fact, the amounts of traffic encounters are continuous and endless as long as the roads exist. As Mattias Esbjörnsson portrays it, "the drivers involve in such encounters use the movement of their vehicles to claim and offer access to the road. Their actions are not only governed by legislations, e.g. adhering to speed limits, but also informal conventions, e.g. being too close, or an aggressive overtake may potentially disturb other users" [28]. The nature of these traffic interactions is very dependent of the contexts in which they evolve, which can be rich and complicated if examined in detail, and can be seen as having unintended cooperative or competitive characteristics. The important thing to notice, however, is that the actions and reaction of every driver have an effect on the action of the surrounding drivers whose reactions are partially dictated by the actions of others and are capable of influencing the other drivers surrounding them as well, and so on.

Given the amount of vehicles that use the roads everyday and the constant interaction in which they are continuously engaging in, it would make sense to argue that traffic-encounters potentially have the ability of influencing the emotions of drivers to a personal level. One obvious example is the negative feelings experienced by the impossibility of reaching a destination on time due to the high levels of traffic.

It is important to observe that many of factors that have been previously discussed and the aspects that cause many of the emotions experienced by drivers can be reduced to some form of interaction with the road, its elements and its users. The effects of lighting on emotions, for example, comes from the interaction of the headlights of another car with the driver, or the interaction from a traffic object, such as lamppost, with the driver. Some of the noises produced by other vehicles are caused by the interaction of the wheels with the road, and in turn interact with the driver in negative ways. The driver could also engage in interaction with the road architectures in some sense. The distance a driver keeps with respect to other cars in order to avoid accidents is a form of interaction, as is honking to a driver whose driving skills are being judged. These, and many other kind of factors, form part of some type of interaction all of which are able to affect the drivers' emotions in some way or another. However this chapter will be concerned mostly with the kinds of social or physical interactions that take place on the road.

8.1 The Unnecessary Traffic

One of the reasons to apply innovative methodologies to capture the experience of drivers other than simple questionnaires or interviews is that people's responses when asked their opinion about their emotions or experience while driving tend to be negative and directed towards complaining on traffic, i.e. the quantity of cars and the inability of others to drive. These opinions are based in the recollection of their past experiences, and unfortunately the moments that appeared to be carved deeper on their minds are recapitulations of bad experiences on traffic. However, there is much more to the experience of driving that being stuck in traffic or being annoyed by the style of driving of others, as Lynch observes "when so many people spend so much of their time on the road, when they persist in driving for pleasure, it may be that driving is more than a necessary evil" [2]. This thesis had the purpose of unveiling those pleasures that make the road more than a necessary evil, some of which have been presented in the previous chapters where drivers expressed their positive feelings while driving and the factors that created them. However, the factor of high levels of traffic as it is, i.e. the accumulation of vehicles on the same road, is one that was repeatedly manifested as being unpleasant for the driving experience.

The most frustrating fact is that the current existing traffic in some big cities could have been avoided if careful planning was carried out as well as disambiguation of conflicting political interests. This knowledge, of traffic being unnecessarily existent, has created a mixture of feelings in some drivers who try to understand both sides of the story. For one they experience anger and frustration. It is not their fault that daily traffic happens to occur on the street they are used to take to work everyday. They constantly complain about other drivers, exclaiming comments like "why isn't anybody moving" and "what the hell are these people doing here" without apparently realizing they are one of those people and the fact that they are contributing to the amounting of cars and therefore the creation of traffic. On the other hand they also experience a feeling of pity for the significant others who, like them, are unfortunate enough to also be stuck in traffic. They also try to understand the reasons for the existence of traffic. In one instance, one driver found herself suddenly stopped by a congregation of people creating, at that very moment at her very spot, a political manifestation. She couldn't determine if she should be annoyed at the people who were creating the protest rally or to focus her anger on the social injustices created by the government who was in turn causing the people to manifest.

As mentioned above, the feelings of frustration that are caused by traffic arise from the helplessness to change the situation and the drivers' apparent inability of reaching their desired destination on time, specially if they did not planned for the event of finding themselves stuck or moving really slowly in the middle of their journey. These initial aggravating feelings are easily

increased as time goes by and by the unchangeable circumstances, sometimes causing the driver to make wild maneuvers or react impulsively in order to find alternative routes. Some participants in the methodologies even confessed feelings of stress just by stepping out on the streets and watching the high amount of cars. Besides the factor of time, noise, and the accumulation of cars, another reason that can account for the annoyance of people stucked in traffic is that the neighboring drivers tend to be rude and aggressive, since they are also experiencing feelings of anger and frustration. Therefore, the negative feelings of being stuck in traffic could be rapidly spread to the vehicles involved, even affecting the emotional states of drivers for their activities after their traffic experience.

The bar-graph on Figure 8.1 represents the coded results obtained from the Experience Sampling Method (see Table B.4), showing the frequencies of the interpreted affect according to Larsen's circumplex (Figure 3.3) grouped by the traffic level perceived by the respondent at the moment the questionnaire was answered while driving. This is proof of the almost obvious fact, that high levels of traffic can be correlated with negative affective states.

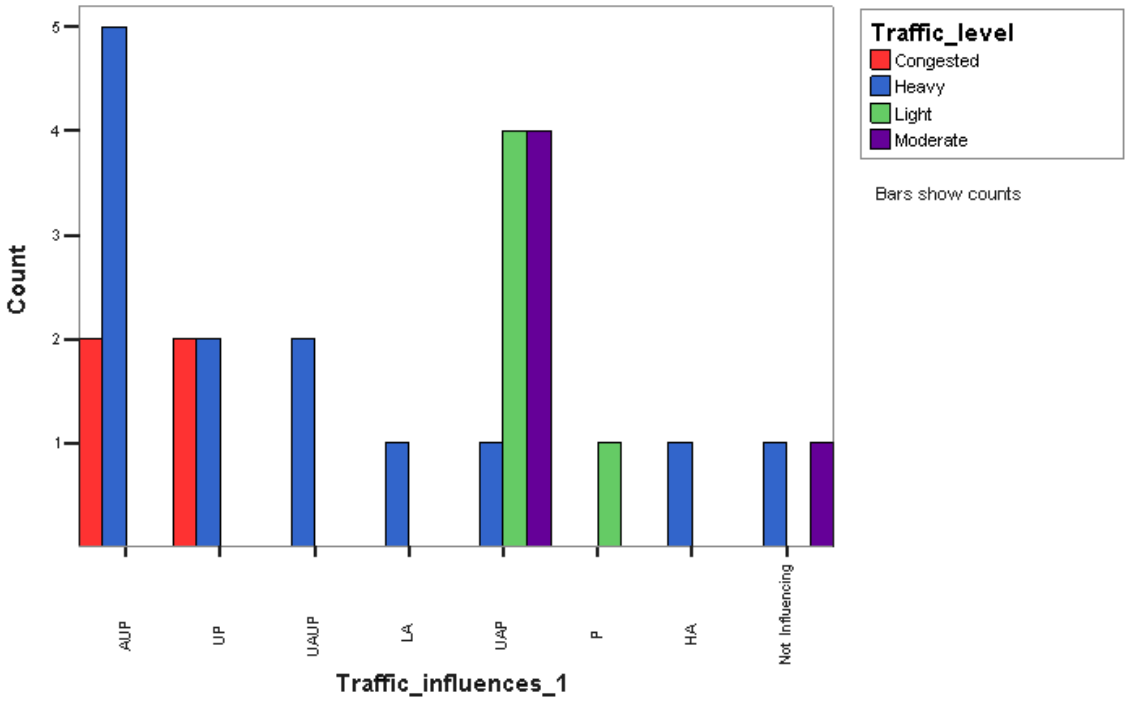


Figure 8.1: Bar graph of traffic levels and its influence on core affect according to Larsen's Circumplex [64]

Notice how levels of *Heavy Traffic (Cars Everywhere)* appear more frequently on the categories to the left of the circumplex, *Activated UnPleasant*, *UnPleasant* and *UnActivated UnPleasant*, while *Light* or *Moderate* levels of traffic appear more frequently under the *UnActivated Pleasant* and *Pleasant* categories.

Even experienced drivers, who are more mature at driving and who have knowledge and understanding of the traffic situations show impulsive responses to other drivers repeatedly [56]. "Getting angry is a positive effort to construct a new meaning of the situation" [56], i.e. the anger experienced by drivers can be seen as a natural process that drivers undergo when feeling trapped in traffic in order to take action and constructively move forward towards a solution.

8.2 Road Interactions

8.2.1 Relative Position

The act of driving is very concerned with the relative distance that the driver keeps with respect to the cars around him. If the driver perceives a vehicle approaching too close to his car it will take immediate action to keep the other vehicle away at a safe distance. The action he takes is provoked by a sudden rush of fear and worry at the possibility of damaging his car or the other driver's, which could bring many possible tedious or dangerous consequences, such as having to stop, argue with other driver, and wait for insurance processes. All these take considerable amounts of time and effort for the driver as the result to the unplanned event of an accident.

The relative position of one's vehicle could also serve as indications of aggressiveness or politeness towards other drivers. The way a driver maneuvers the vehicle can be interpreted by others in the forms of physical gestures, such as a courteous yield of passage to others by stopping the car and letting enough space for another vehicle to get inside, or as a hostile way of sneaking in their place, by pressing the accelerator, clutching in and out, and aggressively throwing the car at them fighting for road space. These maneuvers or car gestures are common forms of road interaction and can cause tremendous impacts on the feelings of others, as well as on the feelings of the driver when someone else does it on him. Simple polite gestures, which often last a few seconds, can make the beneficiated driver extremely content for a moment (as can be seen in blog 13 of Table C.2), while aggressiveness and the application of the 'law of survival' can irritate drivers tremendously for the remaining of his journey.

Even when cars don't become dangerously close to each other, the action of overtaking a driver through either lane at great speeds (or whatever the driver considers a great speed) can become annoying at times. An example can be seen in the video (Helsinborg 009 at `http://www.youtube.com/djjupa`) when a car passes the driver unexpectedly through the left lane with more speed and the driver shows his annoyance towards that kind of behavior. Similarly, the act of tailgating can infuriate some drivers who could feel intimidated by the pressure that another car is imposing on them. Tailgating occurs most of the time on purpose, since experience drivers know how to keep their distance, unless they want to convey a message to the driver in front, which usually is the desire to overpass him and go faster.

Correlation between speed and vehicle flow

One characteristic of undertaking long journeys on big roads, such as highways and freeways (journeys between different towns or cities) is that the set of cars on the road tend to flow together through the whole journey depending on their relative speed. Through his journey the ordinary driver will usually overtake several others while at the same time he will be overtaken by those same several others as well, with those *others* being the drivers traveling at relatively the same speed and that he has previously overtook and that he will possibly overtake again in a near future. This kind of pattern or behaviour is unintended and most likely unnoticed by the driver, therefore having little direct impact on his emotions, but providing opportunities for engaging in more proficient forms of interaction with the aid of wireless or similar technology.

Explicit proof of this form of interaction can be seen on some of the videos captured through the talk-aloud-protocol (`http://www.youtube.com/watch?v=GxFbC8klDVE`), when the driver was traveling in the Swedish highway to Stockholm and noticing how a vehicle that he was overtaking one more time had overtook him previously in two occasions

8.2.2 Speed

Many drivers enjoy the speeding sensation of driving, although many of them speed in order to get to their destination in time rather than to feel a pleasurable sensation. However, the pleasure of speeding over a certain limit is constrained by traffic laws and also by the quantity of other cars and their relative velocity. Drivers tended to express their frustration at their inability to go as fast as they would like to, due mainly to the clustered traffic. The comments *'[Drivers] are too slow, it annoys me, so I have to drive evading them in the heavy traffic.'* or *'[I] look for empty lanes that move faster.'* or *'It excites me that I can go faster now that the city is almost empty.'* from Table B.3 are indicators of the desire of some drivers at some occasions to be able to move faster or to move at all. Some drivers become impatient at the inability of moving faster, others are also intolerant at other drivers who are slow. Speed is also related to the feelings provided by openness and motion, they could give a sensation of freedom and excitement in some drivers, but speeding can bring feelings of anxiety and fear in other drivers or passengers.

The sensation of speed is in great part provided by the other vehicles traveling around the driver. One can have an idea of his own fastness or slowness depending on the speed of other drivers. A good example of the sense of speed can be seen on the video log *High speed driving on freeeway* (found at http://www.youtube.com/watch?v=Jub-eyXwq2s) which shows two vehicles traveling at great speeds and steering their cars through the slower encountered vehicles along the highway. The video shows a nice flow of traffic from the point of view of these drivers, however it might be seen as irresponsible and reckless from the standpoint of the other drivers being passed by and cut off. The comments provided to this video show the mixed attitudes towards the speed factors on the road, while some users comment on the nice speed experience and maneuvering through cars (e.g. *'Amazing driving I must say'*), others show their aversion towards that inconsiderate style of driving (e.g. *'You are an idiot. It's you stupid fools who wind up being scraped off the pavement'*). In general, the sensation of continuous speed, if not excessive and abrupt, can give pleasurable feelings for the driver and passengers experiencing it, but can elicit negative feelings in the adjacent drivers left behind.

Evidence for this was observed on the various ethnography sessions, where drivers tend to express their discontent at the occasions when a driver overtook them through the left lane at considerable greater speeds (see video *'Driving in Lund'* at www.youtube.com/djjupa). However, if the opposite happened, in other words if the driver was the one overtaking some other cars at greater speeds, the driver showed, through his postures and expressions, his feelings of power and of being in control (see example on video *'Stockhom E4 overtaking cars'* at www.youtube.com/djjupa).

8.2.3 Communication Between Drivers

The road environment can be seen as an immense pool of actors under constant synergy, inevitably becoming in contact with one another either directly or indirectly. Given that a regular driver encounters at least hundreds of others vehicles along an ordinary journeying day, and those hundred others get in contact with hundreds other more, the network of occurring interactions expands tremendously fast [28], and the influence on each other's emotions becomes unavoidable. As of now, there are only a few current explicit ways in which drivers involved in these thousands, or maybe millions, of concurrences can interact with one another while they traverse the roads.

Body Gestures

A common form of interaction between drivers on the road includes the use of body parts to convey meaning through gestures. The most obvious signal is perhaps moving the hand upwards showing the backside of the palm or nodding affirmatively once as a way to express gratitude at yielding passage. Another is the permission to change lanes by taking out the hand and shaking it a couple of times to indicate the need to occupy that space. These are examples of explicit ways of communication, however, most common are the ways in which drivers interpret the movements that others perform unconsciously, such as the movement of the head to the left or right as an indication that the action of changing lanes is being considered, or moving the car slowly as the driver leans forward in order to check for oncoming traffic when turning at an intersection. In order to catch these unintended gestures drivers and other road users have to be very attentive, and their understanding comes with experience. The emotions of drivers are affected in this case when the driver, despite signaling his intentions through bodily gestures, does not get taken into account, making him become angry at the careless driver or drivers who purposely or accidentally ignored him.

Misusing the Honk

Some countries, like Canada and Sweden, do not have the culture of honking at the every opportunity they have, they are more patient and understanding of the driving ways of others, hence using the car's horn only in special circumstances. Other cultures seem to have it as a hobby, over using the horn to the point that can affect the health of road users, and becoming stressful for everybody. Drivers from Mexico reported several times the honking noise of cars as really annoying, with none of them confessing to engage in the honking activity themselves. Truth is that under some circumstances, such as high traffic situations, people tend to honk as a way to express and release their frustration, perhaps hoping that their honking contribution will eventually free the road of obstructing cars, but even when this attempt continuously fails to work they keep honking for some stranger reason. The driver that is being honked at tends to display episodes of nervousness and takes immediate action to correct the mistake that caused the fury of the honkers. The use of the honk could be avoidable to some extend, preventing many drivers from feeling stressed and irritated, but the underlying reasons that people express their frustrations through honking are unknown. It would be interesting to study its causes and to find out if honking is a provocation of the amount of cars traveling through the same road or is it a cultural activity that people in Northern nations, or developed countries, do not practice as much as people in the equatorial regions. From the results obtained in this study it seems that these two factors, amount of cars and the cultural background, or a combination of the two are the main causes of the presence or lack of honking sounds.

These presented interactions are some examples on the current ways drivers can communicate with each other. Ways of enhancing these or new forms interaction have been somewhat disregarded by car manufacturers so far. It has been the task of interested researchers, such as Juhlin and Esbjörnsson, to explore further the ways in which technology can allow drivers to engage in new forms social interactions.

8.3 Interactions Inside the Car

People sometimes enjoy quiet relaxing drives by themselves. Driving is an activity that can provide for some alone time and to get away from the stress of work, family and other troubles. However, driving can also be seen as a social activity, where one can 'drive around' with their friends with no specific destination, just for fun and without a real motive. When traveling with others in the car, some for of verbal interaction is almost forced to happen, since the vehicle serves as a capsule containing only the people inside, separating the driver and passengers from the world outside. Having this kind of social interaction is not an essential part of the driving experience, since it is often the case when the driver travels alone, but driving with other people in the car gives the driving practice some special inexplicable character and provides for a noticeable different experience. People traveling in the same private car with the driver often have some kind of relationship, either friendship, relatives, colleagues, classmates, etc., and it is not so often that drivers find themselves driving with complete strangers. If the bond between the driver and passenger is not strong or they are somewhat unfamiliar with each other, the event of traveling by car, isolated from the outside word, almost forces them to engage in small talk, and sometimes even provoking uncomfortable feelings if there is no conversational chemestry. From the shadow method it was observable that the driver takes a passive role in the conversations if there are more than two passengers in the car. The driver is usually attentive to the conversation taking place, but comments only occasionally, perhaps because of the cognitive overload of driving, listening and talking. However, if there are only two passengers in the car, including the driver, these two will usually maintain a normal conversation without a problem. If the passengers know each other very well their driving activity done for pleasure tends to be really enjoyable and rated as extremely fun.

Chapter 9

A Ubiquitous Road - Implications for Applying Technology on the Road

The previous four chapters describe some of the relevant factors encountered in a road environment that were found to be influential on the drivers' emotions and experiences, according to the results obtained from the applied methods presented in Chapter 4. Now that these general affecting factors have been identified it is possible to suggest possible ways in which ubiquitous technologies can provide the driver with a better emotional experience. The aim of this chapter is not to present specific prototypes or proposed designs, but rather to give some guidelines and sets of implications that will hopefully inform the designs of those prototypes based on the concluding observations and the theoretical foundations around it. Also, it is important to prevent the impact that the introduction of technology could have on the driving experience and in society in general.

One of the leading researchers at exploring the emotional design of things and technologies is Professor Don Norman, whose most prominent work on the role of affect in the process of design can be seen in his book *Emotional Design*. He acknowledges the original role of designers, who have to consider many aspects of a product during its design process, but recognized that the design of products rarely considers their embodiment of emotions. He also suggested three different aspects of design, *visceral*, or the appearances of things, *behavioural*, referring to effectiveness and pleasurably of their use, and *reflective*, or how can a product portray the identity of its user [76]. The teachings of Norman have led to the realization that the design of new systems has to go beyond functionality and usability, which are important characteristics of affective computing. But in order to design emotionally engaging artifacts and technologies, designers must have an understanding of the causes, triggers, and consequences of users' emotional states.

Designers and developers of technologies aimed at supporting drivers on the road ought to consider some important facts about the drivers' emotions that can have great impact on their driving patterns and their overall experience. One of these considerations is that people's affective system, the one that controls emotions, is tightly related to their motor system, so that changes in affect influence, through neurotransmitters, the functions of the brain, which in turn signals the movements of the body [77]. In other words, the sensory system perceives the surroundings which are internalized and interpreted by the brain, which in turn activate the muscles to respond accordingly to the particular stimuli. This would suggest that provoking, what Russell calls, *activated* emotions [98] in the driver (i.e. emotions in the top half of the circumplex in Figure 3.3) would probably lead to the reduction of accidents on the road, since activated emotions would allow the driver's motor system to respond faster and swifter in case of a dangerous situation. Moreover, similar research done by Alice Isen et al. has shown that feeling of happiness "broadens

the thought processes and facilitates creative thinking" [77], allowing people to think clearer, more extensively, and make better decisions [35] interestingly enough, according to Isen, it appears that people do not require large remunerations in order to feel happy. As a matter of fact, another research study mentioned earlier in Section 7.1.1, showed that it does not takes too much effort to embed positive feelings into people and that simply looking at flowers can create sensations of well-being [37]. Designers also have to be aware that, despite the many biological similarities and alikeness of brain mechanisms, there are huge individual differences in the ways people appraise and express affect [77], which makes the endeavor of designing for emotions somewhat lawless and hence challenging.

Designers of road systems can take advantage of the collective knowledge of human emotions and their impact on everyday activity, brain functions and human behaviour. Integrating this knowledge with the recently unveiled emotional altering factors of the road can prove to be beneficial for the successful completion of an *ubiquitous road*.

9.1 New Technological Suggestions Based on Findings of the Study

In very general terms, in order to support the positive emotional experience of drivers on the road with the aid of technology, a series of important main factors should be addressed, which include: the interaction among road users, the amount of light and visibility, the emotional attachment of the driver to the road's surroundings, the powerful use of sounds to affect mood, and the sensations of speed, space and motion, among others, and some general comments are presented below.

Inevitability of interactions

The first factor mentioned is the continually occurring interactivity among drivers and other road users. By the factor of *interaction* we refer to any type of explicit or inherit type of communication between the different actors of the road, these range from the specific interchange of verbal utterances to the more inert condition of being traveling *through* traffic, where drivers still engage in a form of interaction in the sense that they have to coordinate their actions and reactions according to neighboring drivers.

Many drivers complained about being stuck in traffic and the inevitable and helpless fact of being late to their intended destination. Some other drivers take the adequate precautions of leaving their departure point early enough in order to not stress about the factor of time or lateness. From the results obtained in this study, it can be noticed that the frustration and anger of being stuck in traffic arises from the impossibility of reach their goal, their unplanned event of being forced to wait sitting down for reasons out of their control, and the helplessness to change the situation. People do not mind spending hours sitting down without moving when they are, for instance, watching a movie or reading a book. The difference is that they perform those activities willingly, being consciously aware beforehand of the amount of time they will spend at engaging in those activities, while on the other hand, being stuck in traffic appears to be something surprisingly unexpected, even if it is experienced with regular frequency. Current technology has the means of helping the precarious driver in this respect by, for example, providing him in advance with information about the estimated times it will take him to arrive to his desired destination, according to the distance, traveling speed and approximate levels of traffic.

Sometimes, even with the help of technology, traffic would be almost inescapable, and the driver would have to go through it and accept its consequences. In such cases, technological artifacts or services could try to make the experience of being stuck in traffic a little less painful. For example, the Soundpryer prototype [79], developed at the Interactive Institute in Stockholm, is a way of taking advantage of the momentary traffic encounters. This device allows drivers to share music between different cars while traveling, providing the driver with the opportunity to listen to the same music that other surrounding drivers are listening to. "With Sound Pryer one can hear what others play on their stereos and also figure out to which car that stereo belongs" [80]. Being stuck in traffic provides ideal opportunities for the use of this device for longer periods of time and to engage in other forms of social interaction with other road users. Besides, traveling at low velocities while in traffic can allow the driver to perform some of his work if it doesn't take his attention too much away from the road.

The important piece of advice that new technology designers have to take into account is that interaction while driving is unavoidable, which is a property of the road that has been recognized by Oskar Juhlin et al. who tries to take advantage of these traffic encounters with the use of technology.

Light intensities and visibility

Another important factor to be addressed is the overall visibility and light intensities perceived by the driver at different times of the day and under different weather conditions. Amounts of light have been proven to have effects on the emotional state of individuals, besides being an always important influential aspect of the road and its presence or absence is constantly perceived by the driver. In general, it appears that the more illuminated the road environment is, the better the driver feels, and more specifically, the greater the amount of *natural* light that can be perceived the more pleasant feelings are educed. Drivers have shown their preference to drive under sunny days and their nervousness or anxiety to drive under bad weather conditions. While technology is not *yet* able to change the weather or to provide more degrees of sunshine according to the driver's wishes, it can surely provide the driver with information about meteorological conditions and what to expect from his journey in terms of climate.

The degree of visibility can make the driver feel more secure, less tense, and consequently enjoy a more relaxing drive, but unfortunately visibility is considerably reduced at night and by rain or fog. Traffic authorities should find a way of providing more illuminated streets, given the proportion of accidents that occur at night. Perhaps a way to do this could be by augmenting the roads with motion sensitive lampposts, which can regulate their light intensities depending on the presence of a vehicle, saving their energy for when the roads are empty. The recent use of Xenon Lights in cars tries to address this issue by providing the driver with what their marketers claim as almost natural light visibility.

Headlamps are an example of how car manufacturers devise vehicles with the driver in mind, but their mind does not concern the other drivers too much. Headlights are the cause of common momentary annoyances when traveling through dark, unpopulated roads and encountering a vehicle on the opposite direction that forgets to lower down the high-beams. Nevertheless high-beams are also used by the driver and are sometimes essential for his visibility. Sometimes drivers tend to make short complains about the other forgetful drivers coming on the opposite direction who fail to remember to lower the headlights, as if they would never do such a neglectful thing. However, these episodic moments of headlight forgetfulness is a way in which drivers have a chance to interact and which form part of the driving experience. The aim of technology in this case is not to simply find ways of automatically turn off the high headlights when detecting, possibly with

the use of light sensors or radars, that a vehicle is approaching in the opposite direction, but rather to find a way to compensate for that unintended interaction and turn it into a positive account.

Emotional attachment to the road

One more important factor is the *communication* or *connection* of the driver with his landscapes and surroundings. This refers to the information that the road conveys to its users, such that the driver feels connected with some elements or segments of the road. This idea comes from the fact that drivers, who travel considerable long distance in average [28], have already some kind of established emotional attachment to some element or situations along their journey, therefore technology could enhance that existing bond between the driver and the road's architectures and landscapes. As of now, the only traffic objects capable of conveying practical information are perhaps the existing road signs. An improvement to this, with the help of technology, could be augmenting buildings, parks, churches, bars, etc. with personalized tags that could remind the driver, perhaps through media elements (short videos, pictures, music, voice narrations, etc.), of the special connection with that particular place along the road as he drives through it. Usually the emotion elicited by the affective attachment to elements of the road already exists, hence the aim of technology in this case would be to create casual, but unobtrusive, cues that will in someway stimulate the driver's senses in order to *intensify* the positive emotions that road elements provoke.

Yet, technology that supports this characteristic ought to be aware that people might also have negatively emotional attachments to some segments of the road. Cruising through certain streets, the driver might be reminded of unpleasant events that occurred in his life, such as the dead of a loved one or a traumatic crash, and would not like to be reminded of those events. This raises the challenge of how to feed a computer system with information and what kind of personal information should be submitted, which is a general difficulty for the field of affective computing.

The power of sounds

It could be argued that the main goal of designing technologies for the emotions of drivers on the road would generally be to successfully transform negative experienced emotions into positive ones. One way to modify affect in this way and vice versa, is with the use of different sounds [77]. As presented in Chaper 6, sounds have the power of making people feel euphoric, relax and happy, but they can also irritate them and create anxiety. Hence, the factor of sound should be considered in the process of augmenting roads and vehicles with technology for emotions.

It is often the case when drivers complain on the sounds made by other vehicles, especially big trucks, noisy motorcycles and scratchy sound of old rusty cars, as well as noises caused by their own vehicle, like the tires, pounding rain and wind draft; all these sounds have the power of making drivers annoyed, tense and irritated. On the other hand, some music melodies and the faintly perceived sounds of nature, have the ability of provoking positive feelings on the driver, so that he will become either exited, cheerful, contented, relaxed, etc. By this token, designers of technology could, based on music theories and personalized tastes in different rhythms, look for ways of capturing the repelling sounds created by the road and transforming them into pleasurable melodies enjoyed by the vehicle's passengers. Some researchers have already explored the ways in which noise can be transformed into music, such as Noah Vawter from the MIT [116] who prototyped a device similar to a walkman which synthesizes the noises coming from the urban environment into musical sounds. Therefore, the technology is already existent, is just a matter on finding ways to take advantage of it for the purpose of the road.

Regardless of the noise complains from drivers, external noises also form part of the driving experience. Driving without listening to the surrounding cars or other noises coming from the road would be like cooking without smelling the food. Both of these senses are not essential to fulfill the activities of driving or cooking, but they enrich the experience and provide the individual with cues on the performance of the activity. The noises from the road make the driver feel accompanied, alert in some cases, and identified with the road for the duration of his journey, as long as they are not extremely loud and thumping. The negativity produced by these noises is perhaps the inability of the drivers to turn these noises off at will, as they are able to do with the car's stereo. Listening to music while traveling was reported as pleasant maybe because the drivers have this option of choice of melody, whereas noises from the streets hardly have any melody and the driver has no other options but to listen to it or stop driving. Technology could help drivers in this regard perhaps by providing them with a way of controlling the volume or something alike, so that the drivers can choose to completely isolate the car from the external noises or level the sounds to moderate volumes. The annoyance of excessive honking is something that has to be dealt with as well, perhaps by disabling the car's honk if it detects that several other cars are already honking, therefore avoiding the driver from collaborating with the noise excess.

Excitement embodied in the feelings of speed, motion and space

For some people most of the pleasure for driving comes from the sensation of movement at great speeds while maneuvering the car through *obstacles*, or other vehicles. While designing for technology, it would be optimal to provide the driver with some means of feeling that same sensation, while keeping his safety and the safety of others.

Curiously enough, racing video games are very popular despite they do not provide its players with the physical sensations embodied on the driving activity, such as the wind breezes, the jumpy bumps, the tense grip on the steering wheel, more importantly, the awareness of the presence of others and the inputs from the periphery. Unfortunately, it appears that some people are trying to combine racing games with real physical sensations by taking the driving video gaming experience into real life, recording their speeding journey through the streets and posting their videos on YouTube to brag about their racing times. Not only have racing video gamers more propensity towards real driving aggression and risk taking [74], but they also appear to have lower reaction times on the road than people who do not commonly play. This reckless kind of driving should be regulated by the authorities, and technology could provide ways to enforce this regulation as it has tried to do so with the use of cameras and road signs showing the driver the speed at which he is traveling. However, no matter how many regulations are in place, people will still enjoy the feelings that come with the act of driving, and technology might just provide them with a way to boost their sensations of space and velocity in a proper and safe manner.

Some other people enjoy the sensation of freedom on the streets with little cars around which allow them to display themselves with more liberty. Unfortunately in some cities, such as Mexico City, this sensation is rarely experienced, but in others, such as the streets of Sweden, it is very common. For drivers on cities where the clustering of cars is common, dynamic information on alternative routes with less cars might be useful and appreciated.

The factors just presented are just some of the many aspects that technology could address, but overall, the purpose is to provide drivers with a better experience while on the road and ultimately influence their emotions positively. One radical way to achieve this might be to actually prevent individuals from driving at all. If a computerized system knows that the individual's moods are going to be negatively affected by the current conditions of the road, providing him with what

could be a negative or bad driving experience, then the system could suggest the individual to use alternative means of transportation as an *option* to get to his destination, however allowing the driver to be in control of his final decision.

This raises the point that any kind of technology to be designed for supporting the driving activity should leave the driver in total control of his own actions and decisions. Instead of enforcing practice, technology should support it, and supporting emotions while driving is a delicate issue that could bring consequences if not properly handled.

9.2 The Challenge of Evaluating New Technologies

The new paradigms of computer science carry with it new ways for designers and developers to see the world and make use of their objects. With this new wave of technological artifacts, which provide original forms of interactions of a user with a product or system, comes the responsibility to test not only its functionality and usability, but also its possible effects in the social and routinary processes and practices of its users, as well as any influences on their behaviour, cognition and affect.

The inherited characteristics of emotions make the concept itself difficult to study with concise precision. The tasks of designing for emotions becomes a delicate matter when realizing that, if failed, the product can educe negative emotions on its user and, depending on the activity at hand, bring some serious consequences. For this reason many things have to be considered and not overlooked, the details of the context in which an emotional episode takes place for example, the frequency of emotional displays, the triggering factors, the valence and activations, etc. Yet emotions are intangible and therefore hard to measure; unlike *matter* or *distance*, which can be measured in grams and meters, emotions have no measurable units, and unlike *time*, which is also intangible, but measured in seconds, emotions have no periodicity or known regular patterns, but they come rather sporadically, are very subjective, triggered by different aspects under different contexts and very malleable. Russell's work on core-affect can be seen as an attempt to conceptualize the term of emotions and will hopefully provide with ways to evaluate new emotional designs and affective computing devices.

Sunny Consolvo and Miriam Walker have suggested the use of Experience Sampling Method as a way to evaluate ubiquitous computing application [14]. This method then can serve both, in the design pre-phases as a tool to capture the users' actions and in the task of evaluating design concepts. Consolvo and Walker recognize the variety of tasks and contexts in which ubiquitous computing applications will be used, and the need to test their design under the actual intended contexts of use, for which the Experience Sampling Method proofs beneficial. Other studies related to the field of Human-Computer-Interaction have also employed this method to evaluate their design concepts [43,44,48]. Nonetheless, these studies work mostly with aspects that did not involved emotions, like exploring user needs and preferences [48], behaviours [44], attitudes [43], and which might be easier to capture and measure. For the purpose of evaluating technological suggestions and prototypes aim to influence the emotional aspects of the driving experience the use of the *Experience Sampling Method*, or some similar modification, seems like a promising approach, specially if new high-tech methods of obtaining data are employed, but always keeping in mind that emotions are difficult to express and often unknown or unlabeled [85]. Hence innovating ways to capture them within the Experience Sampling Method might be needed.

An intriguing challenge of the affective computing related fields is the way in which the developers, designers or computer systems themselves will be able to recognize and input *emotion*

and its entailing information into a computer system to later be applied for the better service of people's requirenments. Besides, "the range of means of emotion expression is so broad, with many of this modalities being inaccessible ..., any many others being too non-differentiated. This makes it unlikely that collecting the necessary data will be possible or feasible in the near future" [85]. Another interesting aspect would be the way in which a system would handle emotional data; is it better to store emotions by a particular label, or perhaps by the context in which it took place and the actions that triggered it? In general, it seems that evaluating effectiveness of new technologies that seek to support emotions of people will remain, at least for now, a difficult a challenge.

Chapter 10

Conclusions and Final Thoughts

This thesis has ventured to study the emotions of drivers, mainly, exploring some of the most prominent factors that are able to influence their emotions, which, in turn, are able to influence the road, other road users, and the flow of traffic; therefore considering emotions as an important aspect has the power of shaping an individual's overall driving experience. It commenced its journey by setting three main objectives that were tried to be accomplished through the different presented chapters. These objectives were to, first, capture the drivers' experiences and emotions as they displace themselves through the roads with the use of different research methods and to assess the efficiency of those methods for this special purpose; second, to detect or recognize the main different factors that compose the driving experience and are able to provoke either negative or positive emotions in drivers on the road; and finally to suggest, based on the findings from the applied methodologies, some possible guidelines for the development of ubiquitous technologies that have the intention of supporting the emotional experience of drivers.

In order to accomplish its objectives the thesis presented initially some theoretical background, previous concepts and related research, with the intention of conveying the initial motivation of this study, claiming that research on drivers' emotions have previously been overlooked even when they are fundamental aspect of the activity of driving. Subsequently it explored the intriguing concept of emotion in Chapter 3, to arrive to the conclusion that its definition is still vague, but they are an essential part of an experience; the attempt of some psychologists, such as Russell [98] and Larsen [64], to provide a framework for the study of emotions was also explored in its relation to the experience of driving, but they do not offer the means to capture that experience. Therefore, Chapter 4 presented some research methodologies that have been used in previous research studies and were tailored to fit the context of the road. The attempted methodologies consisted on the use of different *probes*, some *ethnographic* observations, and the *Experience Sampling Method*. From the ongoing analyzes of the material returned by these presented methods, some relevant and very general factors were identified as been important influents on the drivers' emotional experience. These factors included the perceived light, visibility (Chapter 5) and sound (Chapter 6), the landscapes, sceneries and architectures along the road (Chapter 7) and the different forms of interactions occurring while driving (Chapter 8). Based on these findings and factors considered as relevant, Chapter 9 presented some suggestions and general guidelines for the design and development of possible new technologies to be applied on the road environment and to support the emotional experience of drivers.

10.1 General Findings and Discussions

Through the journey undertaken by this thesis, several findings were uncovered or reaffirmed, some of which were expected and help confirm the hypotheses stated at the beginning and some others that were completely unanticipated. Those findings had the intention of informing the development of ubiquitous technologies that could enhance the driving experience, perhaps by making it safer, more pleasant and less stressful, but most importantly, by making the driver aware of his interactions with others and his relation with the context in which he is driving. By making the driver conscious about his *being* in the world and the perception of his actions from the point of view of other drivers, he could become more responsible, and perhaps take advantage of this indirect form of conscious interaction.

In this thesis it was also found that some factors were prominent influentors in the drivers' emotional states while traveling. For example, loud noises made by other vehicles tends to be disturbing for drivers if they occur too often; clear visibility on the road is usually appreciated by drivers, as are well illuminated streets at night. Adorned and decorated roads are a simple way of having a contented driver, whereas dirtiness and vandalism are likely to endow displeasure. Excessive and common amounts of traffic is perhaps the most reported factor that impedes the driver from having a more positive driving experience. Also, uncommon, unexpected or hurried movements or actions of other drivers that put at risk the safety of the driver or his car is often perceived as reckless and irresponsible, leaving the driver with a momentary bad feeling. However, it appears that the negative factors do not outbalance the positive aspects of driving, since people continue to use their vehicles in a regular basis even for running the simplest errands.

It is important to understand that the emotions of drivers are only relevant when considered together with the contexts in which they are portrayed. Emotions are not experienced in a vacuum and more often than not they have a reason to be caused. The results obtained by the methods have shown that those causes for emotions are very related to the range of possible actions the driver is able to perform according to his expectations. For example, if a driver expects to be on time for work because of a road with low traffic he will definitely experience negative emotions if he encounters a road with heavy traffic and is not able to move at his desired pace, probably making him late for work. However, if the driver expects to encounter heavy traffic and he anticipates a slow drive, then his emotions will not be affected in a negative way. The expectation of an experience is probably constructed by previous instances of similar experiences. In this sense, technology that provides the driver with information on what to expect for his next journey might be very well valued. For instance, a system could inform the driver before, or as soon as he gets to the car, on what to expect in accordance to the route he is planning to take to his destination; say, on a main road on a big city in the dark early evening of a Friday night when the local football team has won an important match, then he could expect heavy traffic, low visibility, a number of excited or drunk drivers, noise from honking and the amount of vehicles, etc. With this information the driver could either reroute his journey or restrain from driving, but if he does decides to drive then he will have an overview of what to expect. Of course, what the system is able to inform the driver would differ by much from the actual occurrences of the situated actions taking place, from which the driver can plan his movements just as he is engaging in the activity, but at least he will be prevented with the possible context in which he is about to be traveling.

A general overview of some other most prominent findings is separately presented in the following points:

- Driving, as music and language, could be seen as a "cultural material ... that provides a kind of semiotic and affective 'power' which individuals use in the social construction of emotional feeling and display" [55]. In other words, the very act of driving and the set

of emotions a driver might carry while executing it, is very related, and dependent on, the culture and the context under which it is performed. The actions of drivers and their reactions to the actions of other drivers differ considerably depending on the culture on which they have the most lived experience driving. Drivers will eventually adapt to the style of driving of the surrounding culture, in order to avoid the shameful accountable experience of being identified as a *bad* driver from the fellow, yet unfamiliar, neighboring drivers, who, despite of being strangers, and remaining so for the rest of the journey, their opinion is regarded as relevant when they, perhaps unconsciously, evaluate our own driving skills.

The claim that driving patters are culturally dependent perhaps comes as no surprise, what is interesting is that the emotions of drivers are influenced by the driving patters of a culture, hence they are also culturally dependent. The results obtained throughout this study corroborate this claim, specially since the main comparisons were made between drivers in Mexico City and drivers in the South of Sweden. The Mexican crowded streets, aggressive behaviours, competitiveness for space, unpleasantness of some damaged architectures, etc. tend to influence the drivers' emotions in a negative way, whereas in Sweden it is common to encounter open roads, polite drivers, beautiful landscapes, etc. By this we don't mean that all driving in Mexico is bad and in Sweden is good, but rather we want to portray, by presenting two extremes of a road environment, how the culture affects the context, which in turn affects behaviour, which in turn affects people's emotions. Further verification can be obtained by looking at some posted videos, some of which were used as probes, on YouTube or similar vlog providers, where users have uploaded their captured experiences in different parts of the world depicting very different styles of driving. Some videos show intersections in the streets of India characterized by total chaos and complete disregard for transit rules. Streets of Mexico are shown with accumulation of cars and the impossibility of moving, finding alternative ways of maneuvering the car. Some videos show the streets in the United States, where there are also considerable amount of cars at times, but drivers tend to more respectful of the traffic laws and the streets look more clean and organized.

- Weather is an important factor that influences greatly the driving experience and that was not discussed here at great lengths. Instead, it was mostly mentioned on its relation with lighting and how it affects the level of luminosity of the road and visibility of the driver. Studies on weather while driving could yield interesting findings and disambiguate some unknown factors, such as the reason that drivers tend to feel gloomy while driving slow on the rain, is it because of the lack of light on a cloudy day? On other occasions rain can cause nervousness or increase the alertness of the driver, since it blocks visibility and could make the road slippery, or the pounding sound heavy rain makes on the windshield can become annoying and streesful. Snowy weather also affects the driving experience in many ways, drivers traveling in streets covered in snow are usually more precautious and also alert, while at the same time looking at snowy landscapes is usually pleasant. Excessive heat is another characteristic that can become bothersome for drivers, some of which even prefer to keep their windows closed to avoid the noise from the road.

- As previously mentioned, the amount of data collected for each of methods might be insufficient to corroborate the findings with any level of statistical significance. However the purpose of this thesis is to present the results from different methods with the intention of making the findings more robust, so that if the different methods showed the same tendencies of some aspects of the drivers' experiences it can account as proof towards the corroboration of the hypotheses. This thesis and the presented results will hopefully serve as a steppingstone for more direct and narrow research that studies these factors presented here individually and thoroughly. Its purpose was to study the until now disregarded aspect of the driver's emotions with respect to the flow of traffic, as well as to explore the different

methods that would capture this experiences, and it will hopefully serve as an inspiration for other researchers who want to investigate this topic and its factors more in-depth.

- It will be practically impossible to isolate each of the factors presented on this thesis and study their individual effects on the driving experience. In other words, it is hard to study under natural settings how the driver's emotions are influenced by *sound* without the presence of *interaction* with other road users, or to know the effects of different luminous intensities on emotions while driving without considering the landscapes and city architectures around the activity. It is in fact a mixture of all these variables that constitute the complete and rich driving experience and which evoke in the individual a wide set of moods and emotions.

- One of the purposes of this research thesis was to explore the ways in which the data gathered from the different methodologies provided greater reliability by complementing each other. Some of the methods used yielded better results for some aspects than others, and they provided the study with a better overview of the driving experience from different angles and points of view. We regard this way of collecting data as particularly useful for the purpose of this study, and believe that it could proof beneficial for other studies that intend to inform the design of ubiquitous technologies, hopefully providing the researcher with a more ample and robust set of information to be analyzed and discussed in the process of arriving to more concise conclusions.

  Time for collecting the data was not found to be a significant issue, since the different methodologies can be applied concurrently without the need of waiting for the results of one method to arrive in order to apply the other one. Besides, the analysis of material collected for one methodology could be begun without looking at the material of other methodologies. For this study, some of the initial results obtained by the picture gallery and early observations influenced the design of the subsequent methodologies, which were more focused on particular aspects of the road. The drawback for applying multiple methodologies for the same study is the considerable amount of effort required from part of the researchers, who have to design, apply and analyze the material for each of these methods.

- It is important to keep in mind that the detailed experiences of few individuals, i.e. the subjects who agreed to participate in one or more of the research methodologies presented throughout this thesis, can hardly be representative of the population of all drivers. Recall that emotions and experiences are very subjective and personal, making them hard to capture and harder yet to oversimplify. Nevertheless, many valuable insights can be retrieved from the returned materials and their analyses. The main intention is that this material can provide clues and observable trends on the emotions of drivers and the very broad factors of the road that are able to affect their experience and emotions, therefore influencing their choice of paths and driving patters, factors which account for the flow of traffic.

- The term mentioned by Dourish of *Intersubjectivity* is an important concept that could be considered in the discussion of driving and experiences. Intersubjectivity implies the ability of a driver to understand the meaning of the experiences of other drivers who have their own private thought and feelings, thus experiencing the world in different ways, even when performing the same activity under similar contexts. High levels of intersubjectivity on the road would perhaps result in more considerate, forgiving and empathetic drivers, and hopefully in a more enjoyable experience. The question then is, how can technology be designed so that it raises the level of intersubjectivity on the road. For example, letting other drivers know the *reasons* for your own mood might make them put themselves in your own shoes and understand the reason for your actions, being perhaps more forgiving or understanding.

10.2 Drawbacks and Flaws in the Methodologies

The methodologies used, presented in Chapter 4, were chosen because they were believed to be appropriate for the purpose of capturing the experience of people as they traveled through the streets. However, there are some disadvantages that come with these methodologies or in the way that they were applied for this study. Some of the known issues of applying these methods are for this particular study are:

- One of the main weaknesses of the study was the broad set of issues that it tried to capture. The subject of *the emotions of drivers on the road* allows for many differences in cultural and contextual aspects that are hard to account for, and to make the contexts of study more specific would probably yield better empirical material. It is recommended for future research to concentrate the attention on *one* of the many aspects that constitute the road and try to study that in detail.

- The methods presented in this thesis to capture the driving emotional experience were mostly of a *social* nature. However, Picard [85] has explored ways to capture the emotions of individuals by examining their physiological characteristics, i.e. by measuring heart rates, perspirations levels, postures, tension, skin response, etc. Combining the methods used in this study with more elaborated physiological measurements could perhaps have yielded better overall results and the ability to capture the real, pure set of emotions felt by an individual at a particular moment through his physical characteristics.

  Unfortunately time and resources did not allow the study of physiological responses of participants. However we believe that cross-examining the results obtained from other methods (the observations, questionnaires, videos, talk-aloud-protocol, etc.) with physiological studies of emotion would provide us a more reliable source on the idea of the drivers' emotional state while maneuvering a vehicle.

- The use of other models, such as the OCC model [78], to study emotions could have yielded different interpretation of the captured results. At the moment of interpreting some of the data returned by some of the methods, particularly of the picture gallery and of the Experience Sampling Method, we relied heavily in Russells' circumplex model for measuring affect, which regards emotions as been constituted of two dimensions, valence and activation. Even though this method was useful and simple enough to understand and convey desired ideas, different interpretations of the data might have taken place with the use of other frameworks for emotion. It might be of interest to see the results of a similar study with the use of these other frameworks, but it is believed that in general the overall conclusions would be related.

- Unfortunately the social sciences are not exact sciences like mathematics or physics, which can arrive to definite conclusions after examining numerical results. Instead the social sciences require high levels of interpretation, and in order to diminish the bias towards subjective interpretation in this study, some other outside the study were asked to provide their own deduction for some of the data. For example, people were asked to map the comments on the picture gallery to an emotion on Larsen's circumplex [64], however these interpretations might hardly be a hundred percent accurate.

We consider this work to be just the basic grounds of many other possible research studies on emotions and the road. We are well aware of the many shortcomings of the methodologies and the analyzed data. It is in our hope that this thesis served as an eye-opener for the importance that studying emotional state of road users has on the process of the design of technology. It is left for

curious and interested researchers in the field of mobile technology, emotional design, ubiquitous computing and others to try to unravel the mystery of the driving experience and to carry this study further, continuing to explore the areas that this thesis presented weakly or left unresolved.

10.3 Last Words

As mentioned before, but worth repeating, this thesis tried to capture the drivers' emotions and experiences as they displaced themselves through our communal roads and streets. In other words, it addresses the *beginning* of the yet unexplored and overdue "discussion of turning the highway experience to any positive account" [2], which was recognized and brought to light by Kevin Lynch et al. but unstudied until now. Lynch's observation that drivers insist on using their cars almost daily, even for short distance commutes (at least on the USA), and on spending considerable amounts of time on the road, even when there exists alternative modes of transportation, was a main motivation to find out the underlying reasons for people's joy on driving despite their constant explicit complains on traffic, careless driving, road noise and pollution, etc. It was found that there are many positive aspects of the road, as well as conveniences and commodities of the use of a vehicle that counteract the negative uttered complaints of people. In other words, the act of driving provokes in them at least as many positive emotions as it does negative ones, but it is this hidden pleasure on driving which keeps the streets flowing and which makes people flood them with their vehicles, unfortunately sometimes more than it can handle.

It is in our hope that this study opens up the issue of studying the experience of drivers in the course of developing technology intended at supporting their feelings and emotions, and that it serves only as the grounds for many other studies that also venture to explore the rich, mysterious, unseen and so far disregarded *emotional* environment of the road and all that it embeds. In a way, this thesis had the intention of raising more questions than it could answer, so that the community becomes aware of the many other ways in which this topic could and should be further explored.

List of Figures

2.1 Toyota / Sony POD 6

3.1 The circumplex model of affection represented with colors and shapes. Taken from P. Fagerberg, A Ståhl and K. Höök, *eMoto: emotionally engaging interaction*, [107]. 17

3.2 Circumplex. Taken from J.A. Russell, *Core Affect and the Psychological Construction of Emotion*, [98]. 20

3.3 "The affect circumplex space, with eight affective states represented by forty-eight English adjectives (Larsen & Diener, 1992 [64]; adopted from Russell 1980; Watson & Tellegen, 1985) and the corresponding Swedish adjectives. *Note*: HA = High Activation; AP = Activated Pleasant; P = Pleasant; UAP = Unactivated Pleasant; LA = Low Activation; UAUP = UnActivated UnPleasant; UP = UnPleasant; AUP = Activated UnPleasant." Taken from I. Knez and S. Hygge, *The circumplex structure of affect: A Swedish version*, [61]. 25

4.1 Map provided as an example to participants 30

4.2 Picture of one of the participants of the shadow method. Driving at night through the highway from Lund to Helsingborg. 41

5.1 *'I was annoyed because we had to wait so long for the traffic light to turn green, specially because there were no other cars coming on the other direction'* 59

7.1 *'An avenue surrounded by trees,... they create a peaceful atmosphere, making you feel like you're going through a natural tunnel'* 68

7.2 *'The flowers made the sides of the road very nice. There were flowers everywhere... They made me feel happy...!'* 69

7.3 *'Everybody has the right to show their ideas and preferences, but I don't like this kind of expression in my own city, I feel invaded in my own thoughts'* 69

8.1 Bar graph of traffic levels and its influence on core affect according to Larsen's Circumplex [64] 75

List of Tables

5.1 Some pictures of clear skies and luminous roads 55

6.1 Crosstabulation of sound sources and their influence on emotion 65

7.1 Examples of segments that emotionally attach the driver to the road 70

A.1 Analysis of data from 'An Emotional Road' picture gallery 95

B.1 Presentation of raw data from the 'Experience Sampling Method' 104

B.2 Presentation of data from the 'Experience Sampling Method' (continued) 105

B.3 Presentation of data from the 'Experience Sampling Method' (continued) 106

B.4 Presentation of re-coded data from the 'Experience Sampling Method' 107

C.1 Presentation of data collected from encountered Blogs 108

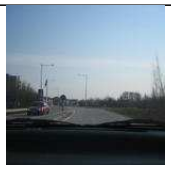
Appendix A

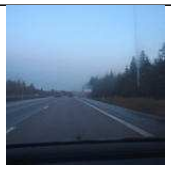
Emotional Road Picture Gallery

Table A.1: Analysis of data from 'An Emotional Road' picture gallery

No.	Picture	City/Country	Comment	Interpreted Emotion	Observations
1		Mexico City (Mexico)	*'A wide avenue free of traffic on a Sunday morning, gives a sensation of freedom, like it allows me to expand myself. It is pleasant to drive an avenue in these conditions, it lets your impulses run free'*	UnActivated Pleasant	Space
2		Ronneby (Sweden)	*'Quite calm and relaxed, paying attention to the road, with friends in the car. It was night time so the streets had few cars and it was a fairly straight forward route mostly along the highway. The time of the journey was probably 1hr 15min, felt quite comfortable, gradually felt more confident'*	UnActivated Pleasant	Interaction, Landscape

3		Ronneby (Sweden)	*'Quite attentive as I still have to watch oncoming traffic with bright lights. Straight forward route but still had to be aware of the right directions to take and to get to our destination. Comfortable and not really nervous with friends in the car'*	Low Activation	Lights, Interaction
4		Lund (Sweden)	*'The old architecture or the old continent, which reminds me of my true home, Makes me feel gloomy and melancholic'*	UnPleasant	Landscape and Surroundings
5		Lund (Sweden)	*'A nice sunny day, but cold outside! Trees without leaves make it feel like winter or autumn. It gets dark rather soon, which is bad, it makes me wanna sleep'*	Low Activation	Lights, Landscape
6		Lund (Sweden)	*'A girl fell off her bike, apparently a car hit her and she went off balance. People around me exclaimed at the moment she fell, they turned they heads and talked about it for the next seconds after it happened. At the beginning I didnt see what was going on, but by the actions of the other passengers I felt compelled to look at what had happened!!'*	Activated UnPleasant	Interaction
7		Lund (Sweden)	*'This two persons on the bike made me feel like biking, because it looked very relaxing and it was such a nice day that it would be better to be outside than sitting inside the car!'*	UnActivated Pleasant	Interaction, Landscape

8		Lund (Sweden)	*'I was annoyed because we had to wait so long for the traffic light to turn green, specially because there were no other cars coming on the other direction'*	Activated UnPleasant	Interaction, Traffic Objects, Light
9		Lund (Sweden)	*'The flowers made the sides of the road very nice. There were flowers everywhere on the way to the beach. They made me feel happy and made me think of Easter which made me even happier since I know ill have holidays soon!'*	Pleasant	Landscape
10		Lund (Sweden)	*'My companion made me happy. It was nice to go with her in the car. We were talking a lot and listening to music from the radio, which made me happy and energetic!'*	Activated Pleasant	Interaction, Sound
11		Lund (Sweden)	*'I felt happy because I was heading to the beach and it was a nice sunny day!!'*	Pleasant	Light
12		Lund (Sweden)	*'Nice that the traffic was not heavy and the blue sky made us feel like going to the beach and motivated'*	Activated Pleasant	Interaction, Light, Weather
13		Kalmar (Sweden)	*'The empty streets of sweden, give a feeling of openness and space. One can drive without worries, but it can get boring sometimes I was actually falling asleep just before the picture was taken'*	UnActivated UnPleasant	Space, Interaction

14		Kalmar (Sweden)	*'It was actually very pleasant to drive because it was one of the first sunny days of the year, even though outside the car was quite cold, but the sun lighted up the surroundings and the snow beautifully'*	Pleasant	Light
15		Stockholm (Sweden)	*'The sun is setting exactly behind the car, it hits the rearview mirrors and it becomes annoying and dangerous'*	Activated UnPleasant	Light
16		Linköping (Sweden)	*'The planes near Linköping bring me memories of my friend and the sunlight behind them makes it even more pleasant. They make me feel nostalgic, gloomy, but content'*	UnActivated Pleasant	Landscape, Light
17		Stockholm (Sweden)	*'We became conscious about the gas and that there still is a long way too go. We started to get worried that the trip to Stockholm might be a little expensive'*	Activated UnPleasant	Speed, Traffic Objects
18		Stockholm (Sweden)	*'The road was kind of misty, the car provides warm, but the atmosphere makes me feel sleepy while driving '*	UnActivated UnPleasant	Light
19		Göteborg (Sweden)	*'Arriving to Goteborg, we were excited, but a little tired from the long trip (it takes like 3 or 4hrs) and not sleeping properly the previous night. There is more live as we approach the big city'*	Activated Pleasant	Interaction, Trip Duration

20		Göteborg (Sweden)	*'The weather was so different in the east and west of sweden. Look at the beautiful blue sky in this picture. Also notice how empty the highway is (an important road in Sweden). Makes it easier for the driver with no cars around. As a passenger it is nice to look at the swedish landscape'*	UnActivated Pleasant	Light, Interaction, Space, Landscape
21		Göteborg (Sweden)	*'We got lost in Goteborg and didnt know exactly were to go, then we got stock in bad traffic. The driver was so annoyed, specially because he wasnt used to bad traffic after living in Ronneby. We saw this car and we all commented and laugh on what it said'*	Activated Unpleasant	Interaction
22		Göteborg (Sweden)	*'On the way to Goteborg, the sky was gray and the weather wasnt great, but we were happy and excited to be on a trip!! We wanted to listen to some music, but the stereo didnt work properly and it was annoying when it broke down'*	Activated Unpleasant	Interaction, Sound, Weather

23		Göteborg (Sweden)	*'On the way back from goteborg to ronneby, we were all so tired. It was so silent, specially because the car had been broken into and the window couldnt close properly which created a lot of noise inside the car and we couldnt hear each other. The sky looked so nice, and a combination of the silence, with the light and going back home created kind of a nostalgic feeling. The weather was so weird, some moments before this picture was taken it was hailing!! '*	UnActivated UnPleasant	Sound, Light, Weather
24		Texas (USA)	*'After this image I felt happy and it called me to have adventures, because it was taken very early I was sleepy, and it helped me to start thinking and kept me awake'*	Pleasant	Light
25		Detroit (USA)	*'This is a picture that was taken by the copilot while I was driving about the 8 Mile of Detroit, which inspired the Eminem movie!'*	Pleasant	Traffic Object
26		Mexico City (Mexico)	*'A man being angry at traffic, which made me laugh because he was cursing everything and I could hear him swearing'*	Pleasant	Interaction
27		Mexico City (Mexico)	*A main road in Mexico City. Stuck in traffic* ,	UnPleasant	Interaction

28		Mexico City (Mexico)	*'This street was closed due to a public manifestation just when I was about to go through it, they did not allow me to get where I needed to go and they reopened the street half an hour later. I had mixed feelings, on the one hand I felt trapped or kidnapped and repressed, but on the other hand I understood that these people protests to social injustices that repress them, while at the same time they are repressing all the others that wanted to use the road. So I asked myself which should be my role in society'*	UnPleasant	Interaction
29		Mexico City (Mexico)	*'My heart is cold in a rainy day'*	UnPleasant	Light, Weather
30		Mexico City (Mexico)	*'Everybody has the right to show their ideas and preferences, but I don't like this kind of expression in my own city, I feel invaded in my own thoughts'*	Activated UnPleasant	Landscape and Surroundings
31		Mexico City (Mexico)	*'An avenue surrounded by trees, it allows me to feel connected with nature even in the middle of a big city, they create a peaceful atmosphere, making you feel like you're going through a natural tunnel'*	UnActivated Pleasant	Landscape and Surroundings

32		Queretaro (Mexico)	*'I love to see the rainbow, but seen it away from the city had a bigger impact on me. It caused me sensation of surprise and tranquility; like after the storm, like in life, that same sensation of having overcome some difficulty, when you can smile again'*	UnActivated Pleasant	Light, Landscape and Surroundings
33		Queretaro (Mexico)	*'When I took this picture I felt emotions about the things that I could find after the tree'*	Activated UnPleasant	Light, Traffic Objects

Appendix B

Experience Sampling Method

B.1 Results from the Experience Sampling Method

B.2 ReCoded Results from the Experience Sampling Method

Table B.1: Presentation of raw data from the 'Experience Sampling Method'

ID	Age	Time	Weather	Speed	Travel_alone	Country	Emotional_State
001Andrea	18-24	Afternoon	Sunny	31-50	Yes	Mexico	Annoyed/Frustrated
002Manuel	41-70	Night	N/A	0-30	Yes	Mexico	Tired/Sleepy
003Daniel	18-24	Night	Windy	71-90	Yes	Mexico	Tense/Stressed
004Ximena	18-24	Morning	Sunny	0-30	Yes	Mexico	Serene/Content
005Pilar	41-70	Afternoon	Partly Cloudy	51-70	No	Mexico	Sad/Gloomy/Depressed
006Rayo	41-70	Afternoon	Rainny	0-30	Yes	Mexico	Serene/Content
007Leticia	41-70	Morning	Partly Cloudy	51-70	Yes	Mexico	Serene/Content
007Leticia	41-70	Evening	Sunny	0-30	Yes	Mexico	Upset/Distressed
005Pilar	41-70	Morning	Partly Cloudy	71-90	Yes	Mexico	Calm/Relaxed
005Pilar	41-70	Evening	Partly Cloudy	31-50	Yes	Mexico	Tired/Sleepy
007Leticia	41-70	Morning	Sunny	51-70	No	Mexico	Excited/Aroused
001Andrea	18-24	Night	Cloudy	31-50	Yes	Mexico	Tired/Sleepy
005Pilar	41-70	Morning	Partly Cloudy	31-50	Yes	Mexico	Calm/Relaxed
001Andrea	18-24	Night	Partly Cloudy	0-30	No	Mexico	Annoyed/Frustrated
008Amiga	41-70	Afternoon	Sunny	31-50	No	Mexico	Tired/Sleepy
008Amiga	41-70	Afternoon	Sunny	51-70	Yes	Mexico	Happy/Glad
005Pilar	41-70	Afternoon	Sunny	51-70	Yes	Mexico	Sad/Gloomy/Depressed
009Camilla	31-40	Afternoon	Sunny	31-50	No	Sweden	Happy/Glad
009Camilla	31-40	Morning	Sunny	31-50	No	Sweden	Happy/Glad
002Manuel	41-70	Morning	Sunny	0-30	Yes	Mexico	Tired/Sleepy
010Lisa	18-24	Evening	Partly Cloudy	51-70	Yes	Sweden	Calm/Relaxed
009Camilla	31-40	Afternoon	Partly Cloudy	31-50	No	Sweden	Serene/Content
005Pilar	41-70	Morning	Sunny	71-90	Yes	Mexico	Happy/Glad
010Julieta	25-30	Morning	Partly Cloudy	71-90	No	Mexico	Tense/Stressed
002Manuel	41-70	Morning	Sunny	31-50	Yes	Mexico	Serene/Content
009Camilla	31-40	Afternoon	Partly Cloudy	31-50	No	Sweden	Happy/Glad
009Camilla	31-40	Night	Sunny	91-110	No	Sweden	Tired/Sleepy
011Rodrigo	25-30	Evening	Partly Cloudy	0-30	Yes	USA	Serene/Content
011Rodrigo	25-30	Afternoon	Sunny	71-90	Yes	USA	Happy/Glad

Table B.2: Presentation of data from the 'Experience Sampling Method' (continued)

ID	What_Influences	Drivers_influences	Lights
001Andrea	The people cleaning the windshields. I am telling them not to do it but they keep doing it.	Yes, drivers that don't obey the rules, who try to turn when they are in third lane	The sun blinds me but it also makes me happy
002Manuel	Amount of traffic and the traffic lights not working properly	Yes, because they have expressions of fatigue and tiredness	The lights from other cars coming in the opposite direction bother me
003Daniel	The expectation to see a tv program that will start in 5 minutes	yes, they are to slow, it annoys me, so i have to drive evading them in the heavy traffic, so I'm traveling fast, filling the little spots the slow drivers leave before starting to move	On the day, is very annoying, the devices of my car are not enough to make my vision completely clear, same with the high lights of the cars in the night, some leave you almost blind
004Ximena	i'm late for class, and iḿ not moving for the freakin traffic	yes, most drivers around me are annoyed, stressed and very aggressive	the only good about my way to school, is sometimes the view of the sun coming and the pink, orange clouds, well only if the pollution is cleared
005Pilar	The street is Not Influencing my emotional state	No	The light from the sun is pleasant at the moment
006Rayo	The traffic. it's awful! also, I feel the resignation of us car drivers about not being able to do anything to change it	yes, because theyŕe too many! and too slow. yes, because I'm changing lanes and so are they	N/A
007Leticia	There are a few cars, the sun is rising, when I pull down the window I can listen the chirping of the birds, I like those sounds	At this time they do not influence too much, since there are few cars and we don't interfere too much with one another	The morning sun starts to clear and gives me a pleasant sensation
007Leticia	There is a lot of traffic and we cannot go forwards, I am hungry and tired	Yes, it affects me, they throw the car at me and I have to brake completely in order to avoid crashing	It is sunny but the weather is template. The light is Not Influencing so much
005Pilar	The flowers are blooming, spring is soon coming!	Only when they are imprudent and do not respect other drivers or pedestrians	They are not affecting it
005Pilar	Slow traffic	The drivers that don't respect the traffic signs	The traffic lights take so long
007Leticia	I am driving through a zone of nice sidewalks and trees along the road that I like and always makes me enthusiastic	Minute by minute the traffic is increasing, some slow drivers and some very aggressive drivers and that produces tension, I pay more attention while driving	The sun, clear and bright makes me feel good
001Andrea	Lots of Graffiti	Yes, when they cut me off	The light on the street is not enough and I cannot see clearly
005Pilar	On one hand trees provoke pleasurable sensations, but on the other hand so many billboards get me nervous and makes me angry.	Yes, a nervous driver that is smoking in the car beside me, he is talking on the phone and yelling.	They are not affecting it
001Andrea	The deterioration of the looks exposed on the road makes you wonder why are they so bad, and makes you feel frustrated and sad	N/A	There is not enough light
008Amiga	Too much Traffic	Yes, because they are intolerant	The heat makes me sleepy
008Amiga	Im going to a dinner. I am happy because it is my birthday!	I don care about them	I like that everything looks lighten when is sunny
005Pilar	Too much billboards and graffiti	Yes, because they are on the third lane to the left and want to turn right or change lanes carelessly	They are not affecting at this moment
009Camilla	The road is dry and clean. It is bright outside	Surprised by another bad driving.	Good sight
009Camilla	Calm, not much traffic	Yes, they drive carefully	In a good way. Good sight, nice weather, daylight.
002Manuel	The noise, the traffic, to find many cars and that they cut me off in the lane I am using	Yes, I feel aggression, competitiveness, desire of others to get to the place they need to be	The day is bright, it stimulates me positively, but the traffic lights take too long, they create tension and an impulse to go through them
010Lisa	Not much traffic. Good weather for driving and good roads	No drivers has (yet) annoyed me. But if they do it may chance my mood in a bad way	Not at all really. It is not yet dark so there is no car lights or street lights that bother me.
009Camilla	The road is dry and clean. It is bright outside	No	Easier to drive because is daylight.ă We also noticed the traffic light
005Pilar	The clear skies, the calm streets, I arrived early to where I wanted to go, and makes me thankful for all the people that left the city for holidays	No, because they are away from the city	no
010Julieta	Constant stress, fear of getting distracted and hit something, specially a person	Yes, definitely an aggressive attitude from the other drivers increases stress	The reflection of the sun can be bothersome and can block visibility
002Manuel	Traffic is not so heavy right not and I managed to do some transactions at the local government, after three times trying before. Besides it is a sunny day!.	Yes, because it is not so early in the morning and people are more calm	Is daylight so there are not too much artificial lights, but the natural light of the sunny day puts you in a good mood, and makes you drive more relaxed
009Camilla	Heavy Traffic	No	I have a good light
009Camilla	It is dark but the road is in good condition, dry road	No	I have to be concentrated and alert
011Rodrigo	I was waiting to cross the rail roads, I was watching the train, and thinking in my work	There was a line of three cars after me waiting for the train, but they do not affect me	It was a cloudy day, but very warm, I do not like to drive in cloudy days, I do not like cloudy days for any activity
011Rodrigo	The landscape full of trees, a lot of cows and ranchs	There were no drivers around me, I like that!!!	There was a lot of ligth because it was a sunny day, I makes me happy to dirve when there is sun and the weather is warm

Table B.3: Presentation of data from the 'Experience Sampling Method' (continued)

ID	Song_rating	Sounds	Traffic_level	Traffic_influences
001Andrea	Im not listening to music	From other cars stress me	Heavy (Cars everywhere)	They made me feel frustrated, they make me agresive and violent, even when I am not usually like that
002Manuel	Im not listening to music	The others made me angry	Congested (Cars not moving)	It is depressing to spend so much time of my life in front of a steering wheel
003Daniel	Im not listening to music	when i hear the engine, it makes me feel iḿ going faster, then i start accelerating and i find myself at high speed a while later	Heavy (Cars everywhere)	it makes me feel annoyed, since itś kind of bothersome to be evading them, because iḿ always ̀running ́ to get somewhere in time, iḿ lazy i admit it, so i always leave my house late
004Ximena	Excellent	the horn noise are simply annoying, and the brake noises too, and when people shout to people, thats the worst	Congested (Cars not moving)	totally, it affects me deeply in my frustration, in my stress, specially if i have class at 9
005Pilar	Im not listening to music	They are not bothering me at these moment	Moderate (Some cars around me)	Traffic is not affecting my emotions at this moment
006Rayo	Excellent	i'm have my window closed, so i donf́ really mind. my radio is ok, it helps me with my mood	Congested (Cars not moving)	yes. it's the time it takes to go home. i donf́ see any reason but too many cars
007Leticia	Im not listening to music	I can listening to the singing of the birds, it gives me the sensation that they great a new day	Moderate (Some cars around me)	I like free streets to drive calmly
007Leticia	Really Bad	Too much noise, I can hear the siren from an ambulance, honk of cars, trucks with noisy engines. All these makes me have my window closed	Heavy (Cars everywhere)	I get angry at drivers that cut you off abrubtly and without looking, you have to be careful of such drivers.
005Pilar	Im not listening to music	My car makes a lot of noise, the fan makes me nervous	Moderate (Some cars around me)	I dont mind them
005Pilar	Im not listening to music	No	Heavy (Cars everywhere)	It makes me sleepy
007Leticia	Good	I can hear my mobile ringing, it is in the trunk. For a moment I consider pulling aside to get it out, but i would be late for work, so I cannot go get it	Heavy (Cars everywhere)	Traffic frustrates me, I try to be calm and look for lanes that move faste
001Andrea	Im not listening to music	The noises outside keep me alert	Heavy (Cars everywhere)	There is a lot of traffic, I am very tired and I am falling asleep
005Pilar	Im not listening to music	They do not affect me at this moment	Heavy (Cars everywhere)	There is heavy traffic, but I have enough time which prevents me from being tense
001Andrea	Im not listening to music	horns make me mad and tense	Heavy (Cars everywhere)	I run out of patience and start to become desperate. I feel It'm loosing my life inside a damned car
008Amiga	Nothing Special	Cars alter my nerves	Heavy (Cars everywhere)	It gets me depressed
008Amiga	Good	They do not affect me at this moment	Heavy (Cars everywhere)	I am serene
005Pilar	Im not listening to music	I can stand them	Heavy (Cars everywhere)	Traffic is not affecting my emotions at this moment
009Camilla	Nothing Special	Not at all at the moment	Moderate (Some cars around me)	Really good
009Camilla	Nothing Special	In a Calm Way	Moderate (Some cars around me)	Car drive in a calm way-No reason to feel stressed
002Manuel	Im not listening to music	The honking is bothering me, there is a great variety of sounds, the most annoying ones are the engines of the trucks	Congested (Cars not moving)	It is definitevely negative, simply looking at heavy traffic produces negative reactions, even when trying to control one's self
010Lisa	Nothing Special	the radio allmost never affects my mood in a bad way. It is more just a way to make the driving more ejoyable.	Light (The streets are almost empty)	I like it most when there is little traffic because then there is less cars that can make me annoyed=)
009Camilla	Good	It doesnt affect me in a negative way. Music influences me in a positive way, it makes me feel relaxed	Moderate (Some cars around me)	You need to pay more attention. I am used to have cars around me so I am not bothered by them.
005Pilar	Im not listening to music	I am calm because there are not to many noises	Light (The streets are almost empty)	It excites me that I can go faster now that the city is almost empty
010Julieta	Im not listening to music	Honking noise increases my stress	Heavy (Cars everywhere)	The level of stress is definitive. The more cars there are on the road (at least the perceived number of cars) the more chances there is of an accident happening
002Manuel	Nothing Special	My windowns are closed, so the noise doesnt get in as much and I can only hear the news from the radio. Since is a litle late there are not much news, but calm music	Moderate (Some cars around me)	When there's less traffic there is more flow, and allows for better driving, much calmerdo
009Camilla	Excellent	Nothing special, they don't influence me negatively	Heavy (Cars everywhere)	I have to be observant
009Camilla	Nothing Special	The winter tires sound a bit annoying	Light (The streets are almost empty)	Positively
011Rodrigo	Excellent	I was listening the music and the train passing in front of me	Moderate (Some cars around me)	It does not make any change in my emotions while driving
011Rodrigo	Excellent	I was listening the music in a very high volume, I just was listening the music	Light (The streets are almost empty)	I like to drive in the highways of this town, they are always empty.

Table B.4: Presentation of re-coded data from the 'Experience Sampling Method'

ID	Age	Time	Weather	Speed	Travel Alone	Country	Emotional State	What Influences	Drivers Influences	Light Factors	Lights Influences	Song Rating	Sound Influence	Sound Factors	Traffic Level	Traffic Emotion	Other
001Andrea	18-24	Afternoon	Sunny	31-50	Yes	Mexico	AUP	Other Road Users	Careless Driving	Natural Light	Good Influence on Emotions	Im not listening to music	Bad Influence on Emotions	Other Vehicle's Sounds	Heavy	AUP	N/A
002Manuel	41-70	Night	N/A	0-30	Yes	Mexico	UAUP	Traffic Objects	Attitude/Emotions of others	Vehicle's Lights	Bad Influence on Emotions	Im not listening to music	Bad Influence on Emotions	Road Users	Congested	UP	UAUP
003Daniel	18-24	Night	Windy	71-90	Yes	Mexico	AUP	Heavy Traffic	Speed (Fast/Slow)	Vehicle's Lights	Bad Influence on Emotions	Im not listening to music	Good Influence on Emotions	Vehicle Sounds	Heavy	AUP	AUP
004Ximena	18-24	Morning	Sunny	0-30	Yes	Mexico	UAP	Heavy Traffic	Attitude/Emotions of others	Natural Light	Good Influence on Emotions	Excellent	Bad Influence on Emotions	Other Vehicle's Sounds	Congested	AUP	HA
005Pilar	41-70	Afternoon	Partly Cloudy	51-70	No	Mexico	UP	Not Influencing	Not Influencing	Natural Light	Good Influence on Emotions	Im not listening to music	Not Influencing		Moderate	Not Influencing	UP
006Rayo	41-70	Afternoon	Rainny	0-30	Yes	Mexico	UAP	Heavy Traffic	Quantity of Cars	N/A	Not Influencing	Excellent	Good Influence on Emotions	Music / Radio	Congested	AUP	AUP
007Leticia	41-70	Morning	Partly Cloudy	51-70	Yes	Mexico	UAP	External Environment	Quantity of Cars	Natural Light	Good Influence on Emotions	Im not listening to music	Good Influence on Emotions	External Environment	Light	P	P
007Leticia	41-70	Evening	Sunny	0-30	Yes	Mexico	UP	Heavy Traffic	Attitude/Emotions of others	Natural Light	Good Influence on Emotions	Really Bad	Bad Influence on Emotions	Other Vehicle's Sounds	Heavy	UP	LA
005Pilar	41-70	Morning	Partly Cloudy	71-90	Yes	Mexico	UAP	External Environment	Careless Driving	N/A	Not Influencing	Im not listening to music	Bad Influence on Emotions	Vehicle Sounds	Moderate	UAP	UP
005Pilar	41-70	Evening	Partly Cloudy	31-50	Yes	Mexico	UAUP	Heavy Traffic	Careless Driving	Road Lights	Bad Influence on Emotions	Im not listening to music	Not Influencing		Heavy	UAUP	AUP
007Leticia	41-70	Morning	Sunny	51-70	No	Mexico	AP	External Environment	Quantity of Cars	Natural Light	Good Influence on Emotions	Good	Bad Influence on Emotions	Road Users	Heavy	AUP	AUP
001Andrea	18-24	Night	Cloudy	31-50	Yes	Mexico	UAUP	External Environment	Careless Driving	Road Lights	Bad Influence on Emotions	Im not listening to music	Good Influence on Emotions	Other Vehicle's Sounds	Heavy	UAUP	N/A
005Pilar	41-70	Morning	Partly Cloudy	31-50	Yes	Mexico	LA	External Environment	Attitude/Emotions of others	N/A	Not Influencing	Im not listening to music	Not Influencing		Heavy	LA	N/A
001Andrea	18-24	Night	Partly Cloudy	0-30	No	Mexico	AUP	Traffic Objects	Not Influencing	Road Lights	Bad Influence on Emotions	Im not listening to music	Bad Influence on Emotions	Other Vehicle's Sounds	Heavy	AUP	N/A
008Amiga	41-70	Afternoon	Sunny	31-50	No	Mexico	UAUP	Heavy Traffic	Attitude/Emotions of others	Natural Light	Bad Influence on Emotions	Nothing Special	Bad Influence on Emotions	Other Vehicle's Sounds	Heavy	UP	N/A
008Amiga	41-70	Afternoon	Sunny	51-70	Yes	Mexico	P	External Environment	Not Influencing	Natural Light	Good Influence on Emotions	Good	Not Influencing		Heavy	UAP	N/A
005Pilar	41-70	Afternoon	Sunny	51-70	Yes	Mexico	UP	External Environment	Careless Driving	N/A	Not Influencing	Im not listening to music	Good Influence on Emotions	Other Vehicle's Sounds	Heavy	Not Influencing	N/A
009Camilla	31-40	Afternoon	Sunny	31-50	No	Sweden	P	External Environment	Careless Driving	Natural Light	Good Influence on Emotions	Nothing Special	Not Influencing		Light	UAP	LA
009Camilla	31-40	Morning	Sunny	31-50	No	Sweden	P	Light Traffic	Careful Driving	Road Lights	Good Influence on Emotions	Nothing Special	Good Influence on Emotions	External Environment	Moderate	UAP	N/A
002Manuel	41-70	Morning	Sunny	0-30	Yes	Mexico	UAUP	Other Road Users	Attitude/Emotions of others	Road Lights	Bad Influence on Emotions	Im not listening to music	Bad Influence on Emotions	Vehicle Sounds	Congested	UP	UAUP
010Lisa	18-24	Evening	Partly Cloudy	51-70	Yes	Sweden	LA	Light Traffic	Careful Driving	N/A	Not Influencing	Nothing Special	Good Influence on Emotions	Music / Radio	Light	UAP	UAUP
009Camilla	31-40	Afternoon	Partly Cloudy	31-50	No	Sweden	UAP	Traffic Objects	Not Influencing	Natural Light	Good Influence on Emotions	Good	Good Influence on Emotions	Music / Radio	Moderate	UAP	No
005Pilar	41-70	Morning	Sunny	71-90	Yes	Mexico	P	Light Traffic	Quantity of Cars	N/A	Not Influencing	Im not listening to music	Good Influence on Emotions	External Environment	Light	UAP	AP
010Julieta	25-30	Morning	Partly Cloudy	71-90	No	Mexico	AUP	Other Road Users	Attitude/Emotions of others	Natural Light	Bad Influence on Emotions	Im not listening to music	Bad Influence on Emotions	Other Vehicle's Sounds	Heavy	AUP	N/A
002Manuel	41-70	Morning	Sunny	31-50	Yes	Mexico	UAP	Light Traffic	Attitude/Emotions of others	Natural Light	Good Influence on Emotions	Nothing Special	Good Influence on Emotions	Music / Radio	Moderate	UAP	UAP
009Camilla	31-40	Afternoon	Partly Cloudy	31-50	No	Sweden	P	Heavy Traffic	Not Influencing	Natural Light	Good Influence on Emotions	Excellent	Good Influence on Emotions		Heavy	HA	AP
009Camilla	31-40	Night	Sunny	91-110	No	Sweden	UAUP	External Environment	Not Influencing	Road Lights	Bad Influence on Emotions	Nothing Special	Bad Influence on Emotions	Vehicle Sounds	Light	UAP	P
011Rodrigo	25-30	Evening	Partly Cloudy	0-30	Yes	USA	UAP	Traffic Objects	Not influencing	Natural Light	Bad Influence on Emotions	Excellent	Good Influence on Emotions	Music / Radio	Moderate	Not Influencing	AP
011Rodrigo	25-30	Afternoon	Sunny	71-90	Yes	USA	P	External Environment	Quantity of Cars	Natural Light	Good Influence on Emotions	Excellent	Good Influence on Emotions	Music / Radio	Light	UAP	UAP

Appendix C

Cultural Probes

C.1 Questions on postcards

The following questions were printed at the back of the postcards:

- How do other drivers affect your emotions? Are they usually polite or rude to you? Are you usually polite or rude to them?
- What are you thinking or feeling about the cars around you while you wait for a traffic light to be green?
- What are the main reasons that would make you choose a different path other than your normal one to your usual destination? (Weather, traffic, etc?)
- What do you find interesting or annoying about the drivers around you?
- How do you think other drivers, pedestrians or bikers influence your feelings while you are driving?
- Would you like to momentarily communicate with the drivers around you? In which way and for what purpose?
- Do you think other drivers, bikers or pedestrians influence the path you choose to your destination? How?
- Do the passengers of your car influence the way you perceive other cars and the roads you take? How?

C.2 Text Blogs

Table C.1: Presentation of data collected from encountered Blogs

01	**Kryptonite for the Stupid: Driving to New Orleans**	thephilosopersstone.blogspot.com/2007/04/driving-t...

"The approach to Mobile was the most interesting sight of the drive so far. Large, large body of water (Mobile Bay) punctuated with marshes vaguely reminiscent of the Dead Marshes in Lord of the Rings. Mobile's majestic skyline penetrating the haze like one of the Two Towers. And then a sign: tunnel approaching. No hazardous materials.
Once you pass the sign you cross a very long bridge.
I wish they'd make up their minds.
And Mobile's skyscrapers are particularly interesting. They manage to escape the typical glass box model. All two of them. One reminds me of a big slide shaped like a rocketship that used to be in a park near my home growing up. That's the building where Everyone Works. The other one, I guess, really is just a glass box. That's the building where Everyone Else works.
Now at this moment I'm sure I sound terribly patronizing toward Mobile. But you need to understand why: I'm from Orlando. I never get to gloat about my city. Orlando is the Scottish Terrier of America's cities. Small, noisy, but in there with a bunch of much bigger dogs. You can hardly blame it if it struts its stuff awhile when a Chihuahua gets thrown into the cage with it.
Anyway, I crossed the bridge. I admired the bridge. The same bridge in Central Florida would have been much cheaper, had more dirt, cut off more water, and respected less wetland. Note the Indian River bridges.
I admired the tunnel. Clean, sleek white walls pitching up to a bright white strip of flourescent lights. As you descend into it you get a Space Mountain kind of feeling. But as soon as the effect sets in you start rising again and you're out of it. I was worried – downtown Mobile and it's 6 PM. I'm hitting rush hour. And boy did I hit it. It was really touch and go getting around both those cars, but once I did I was on the road again, rocketing out of Mobile to I-10's next great city: Pascagoula, Mississippi."

02	**Food and Family: Driving in the Dark**	food-and-family.blogspot.com/2007/04/driving-in-da...

"As I drove back home after taking my mother to the airport at the end of her visit, I trundled through the evening traffic and watched the moon rise golden, slightly melted at the edge, now it's just past full. I had to get my night eyes back in training, remember to focus my eyes on the lines at the side of the road, not in the middle to get drawn magnetically towards the oncoming traffic. I realised that these days I hardly ever do drive in the dark. I'm usually at home cooking supper as the sun sets. It is my husband and sisters-in-law whose headlights the children watch for at the gate.
Long gone the easy nonchalance of my youth, the disdain with which I secretly regarded those who made a big deal out of setting off home before it got dark. These last couple of weeks, unusually, I've made several late journeys back from Cape Town after having dinner with my clients and though I'm not nervous of the driving after dark, there is a frisson of daring, where I used to be blasé.
The novelty brings back memories: a crazy epic journey in a Landrover from Italy back to England in under 24 hours, driving through the night along the autoroute in France at hours when the only other vehicles are long distance truckers, keeping awake with a supply of Pocket Coffees Ű wickedly strong dark chocolates with a liquid centre of condensed espresso coffee, no music but the noisy chortling of a diesel engine, the so urgent cargo in the back an entire cured Carpegna ham (like Parma ham but far more recherché!), several pecorino cheeses from Pienza, wines from out of the way Italian vineyards, some prized extra virgin olive oil, all due back for a gourmet tasting the next day. Now I don't know how I did it and also wonder Why did I do it?! From time's perspective it seems far more desirable to wander in a leisurely way across France, in daylight to enjoy the view, rather than hurtling madly throught the small hours of the night in a speed/ endurance challenge. Other memories of living in London, where winter darkness engulfs the afternoon rush hour, raindrenched windscreen wipers creating prisms of light from a multitude of headlights in the traffic, the swoosh of tyres through puddles, fog blurring the Christmas lights strung across the high street. Here we're closer to the Equator so the difference between the length of day in summer and winter isn't so pronounced. Our winter evenings draw in when we are already at home, unless we've been out visiting friends late in Cape Town, and high street Christmas lights are only ever seen unlit in the summer sunlight. There are some bonusses to driving through the dusk: against the extra concentration and hands gripping the steering wheel extra tight, I weigh up the glow of setting sun behind the outline of Lion's Head and Table Mountain, the full moon rising benignly to guide me home, stars glimmering above the sea fog that creeps over the road and curtains off our hills, so that the watched for silhouette of black hill against dark sky is strangely absent, making me suspect that I've travelled unwittingly into a different dimension by blindly following the tail lights in front of me! Then the warm lights of home beckon me as I get out to open the farm gate and the moon smiles gently having seen me safely home."

03	**RAPP81's LiveJournal**	rapp81.livejournal.com/305339.html

"In case you didn't hear, I got into a car accident last Wednesday morning, right at the approach to the Sunol Grade.ă This was my first time driving solo since the time change, so fatigue and the sun blinding me made me unalert.ă I rearended someone and toatalled my car.ă I'm fine, so is the other car and driver though."

04	**That Rogers Guy - Road Rage**	ads3-5000.sixapart.com/show/?yuid=1179059445.14706...

"When I was younger Bank Holidays were all about going to the pub on an all dayer, these days they are all about relaxing. After a pretty full on working week I had been looking forward to a stress free Easter break away from the hassles of working life.
So the plan was to drive down to my parents in Dorset on Good Friday morning, coming back on Sunday evening giving us Monday at home before returning to work on Tuesday. Turns out the stress free bit took longer than expected to achieve.
The journey started well, Maisey went off to sleep in the back, Lou was driving and I was on ipod duties. The sun was shining, we were having a good laugh and singing along with the music (mainly when it shuffled to Lou's tracks as mine aren't the most singalong ever). After about an hour and a quarter we reached Bathampton, a beautiful little village on the outskirts of Bath. It costs 50p to use the bridge through the village, but it saves you going through Bath itself. We parked up in the car park of The George pub in Bathampton to give Maisey a feed, the sun was still shining and families were arriving to explore the canal. It was a proper idyllic British morning.
We left the car park and headed over the second bridge in Bathampton, which takes you round a 90 degree bend. When we reached the other side we were confronted by a row of parked cars (which is usual) and a lorry. Now the parked cars were on the lorry's side of the road so we had right of way, but the lorry did not see it that way. He carried on through regardless. In fact he came up to about an inch away from the front of our car. When we reversed he came forward so the intimidating gap never widened. There were a few cars behind us so they too had to reverse. Now if there had been a few more it would have been impossible as they would need to reverse onto the bridge and round the bend.
We were trying to reverse carefully as there was not much of a gap between us and a wall on the left, ans we also needed to whole traffic flow to move back also. The two guys in the lorry did not care, and they were getting increasingly impatient, and as they pushed closer to us again they both looked at us and laughed. Having someone laugh in my face is certainly one of my least favourite things, and I'm afraid it was red rag to a bull. I swore a little, waved my hands a little and pointed to the other side of the road trying to explain that the obstruction was on their side. Lou also joined in with some suitably choice language as we were both feeling the strain of the situation.
As the lorry was so close to us they could lip read. "Don't you call me a ******* ******" the driver shouted back. It was at that point I knew it was getting nasty. Before we knew it the driver and his mate, both adorned in fluorescent tabards, had leapt out of the lorry and were coming straight for us."

05	**Living Deliberately - Now THERE'S an idea!**	http://www.sixredheads.com/2007/03/16/now-theres-an-idea/

"I really dislike the spring change, which makes 5:00 drivers heading right into bright sunshine unguarded by clouds. On Wednesday I nearly hit a kid on ATV; the car going the other way was driving into blinding sun and did not miss. She hit the kid going full force, overturned the ATV, and knocked him clear of it. He had no helmetĚand somehow, miraculously, he got up out of the road and laid down on the shoulder, moving himself out of the way of the oncoming car that likely would have run over his body. I had many, many thoughts in the hours afterward and eventually it crossed my mind that time change (and sun) IS a factor in traffic accidents."

06	**Spiral - Photos**	http://cinderlou.livejournal.com/29457.html

"Driving home from work this day, the sun broke through the clouds for the first time in about a week. There were beautiful shafts of light streaming down from the clouds – the incredible emergence of light after so much greyness. The pic doesn't capture it, but it is the first glimpse of blue sky in a while."

07	**Eric Hodel's Journal**	drbrain.livejournal.com

"**Puerto Rican Driving:** I kind of like driving in Puerto Rico, the rules here are quite a bit different.
On the freeway there aren't slow and fast lanes, people go equally slow in either. The fast lane winds around all the slow cars on the left, right and sometimes even shoulders.
Nobody cares if you tailgate or cut people off. Making a lane change with a gap of two car lengths or less is quite common.
There's no need to stop moving. People will find the natural gaps and make their left and right turns. Everybody else just goes around.
Driving down a narrow road with no center line is no problem. You just get over far enough.
Almost nobody signals, you know when people are going to change lanes by posture or speed.
It feels a lot more natural than most of the driving I've done everywhere else. People seem to trust each other that they won't screw something up."

08	**Living in Greece | Driving in Greece**	http://www.in2greece.com/blog/2007/03/driving-in-greece.html

"The reason why Greek driving is so bad is, I think, twofold. Firstly, it results from poor roads and the lack of good fast motorways and parking facilities in town centers - especially Athens. Secondly, it would appear that the natural anarchic personality of the typical Greek seems to extend to their driving skills resulting in an apparent total lack of concern regarding what constitutes good, safe and considerate driving. The situation of roads all over Greece is slowly improving but the country still has a long way to go before it reaches the excellent driving conditions which you can find in, for example, France or German"

09	**ratheesh: MandhawaWhile driving to Mandhawa, Arjun**	http://ratheesh.livejournal.com/269418.html

"The drive to Mandhawa took around three hours. Until Fatehpur, we drove through the main road from Bikaner to Jaipur. Fatehpur is a small town, where there are several ancient havelis like in Mandhawa, most of which are in dilapidated state. We could see several of them on the way. At Fatehpur, we took a turn and then went through a narrow road going through villages. Only one single vehicle can pass through the road at a time. There is not much traffic, but we had to face couple of vehicles coming against us. One interesting behavioral aspect of drivers in Rajasthan is that they are very "straight-forward" in nature. Even if they see a vehicle coming against them in straight line, they wont budge, and continue moving straight. As the two vehicles come near a head-on collision, a psychological battle would start in their minds. Whoever loses in that battle, would apply break and move his vehicle to one side (in case of Mandhawa, this would mean that the loser would have to move his vehicle off the road itself). Arjun was a pretty brave driver; Every time a vehicle came against us, he managed to drive "straight" till few meters away from the vehicle (I skipped a few heartbeats during all such instances). However, in the end he had to accept defeat reluctantly always, and give way to the other vehicle."

10	**stinerman: And now the negatives of Northern Ohio**	http://stinerman.livejournal.com/138867.html?thread=536179

"The city is just too damn big. They have lanes that they only let taxis and buses in. They have roads that you CAN'T TURN OFF OF during certain hours. I spent around 20 minutes trying to find my way back to the parking garage I bypassed. THIS WILL NOT STAND."

11	**La soporífera existencia de un Don Nadie**	http://sitiosinlugar.blogspot.com/2007/02/ayer-cuando-iba-manejando-del-trabajo.html
"Ayer, cuando iba manejando, del trabajo a mi casa escuché una canción que me recordó a mi papá... es una herida abierta que no hace nada por cerrar."		

12	**Week beginning 5 June 2005 (Interconnected archives)**	http://interconnected.org/home/2005/06/week/05/
"The technology world is a bigger, virtualised California. I've played driving games for years on generations of home computers, consoles, and arcade machines. They were kind-of okay for me–nothing like driving, you understand, but similar enough to be fun. My first driving experience in Los Angeles, however, squashed this understanding completely: Driving games are utterly, totally perfect. They are the precise American driving experience. It's possibly hard to understand if you've only driven on North American streets and freeways. The cars I've driven, growing up, have had more controls than steering and gas. The drivers on the roads I'm used to have always acted differently. But on American freeways, people drive "defensively" which means they tend to ignore you and stick to their lanes, rarely indicating, and usually all keeping to the same speed, meaning mirrors aren't too important and keeping in line is a simple experience. Sounds just like your typical driving game, in other words, and also completely unlike British motorways."		

13	**Giingo XVI - Momentos de tráfico**	http://giingo.org/bitacora/pivot/entry.php?id=350
"Hoy, al cruzar la rotonda de la avenida Primero de Mayo, el coche que iba por mi izquierda en el carril interior, no sólo no se me ha cruzado para seguir recto, sino que ha reducido la velocidad y ha señalizado hasta que yo pasara. Casi se me cae una lagrimilla de la emoción."		

Bibliography

[1] Julio Angulo. Road and streets - a common place for interaction. In *SIDeR '07: Proceedings of the Scandinavian Student Interaction Design Reseach Conference '07*, pages 21–24. Akademi Sydost, March 2007.

[2] Donald Appleyard, Kevin Lynch, and John R. Myer. *The View from the Road*. The Joint Center for Urban Studies of the MIT and Hardvard University, Cambridge, Massachusetts, 1964.

[3] Canadian Medical Association. Visual acuity and night driving. *Canadian Medical Association Journal*, 70(6):687–688, June 1954.

[4] André Berton, Dirk Bühler, and Wolfgang Minker. Smartkom-mobile car: User interaction with mobile services in a car environment. In *SmartKom: Foundations of Multimodal Dialogue Systems*, pages 523–537. Springer Berlin Heidelberg, 2006.

[5] Kirsten Boehner, Rogerio DePaula, Paul Dourish, and Phoebe Sengers. How emotion is made and measured. *Int. J. Hum.-Comput. Stud.*, 65(4):275–291, 2007.

[6] Barry Brown and Mathew Chalmers. Tourism and mobile technology. *Proc. Euro. Conf. Computer Supported Cooperative Work (ECSCW 2003)*, pages 335–354, 2003.

[7] Liselott Brunnberg and Oskar Juhlin. The road rager: making use of traffic encounters in a mobile multiplayer game. In *MUM '04: Proceedings of the 3rd international conference on Mobile and ubiquitous multimedia*, pages 33–39, New York, NY, USA, 2004. ACM Press. http://doi.acm.org/10.1145/1052380.1052386.

[8] BuyYourCar.co.uk. Ford ka car review. Found at http://www.buyyourcar.co.uk/CarReviews/Ford/Ford-Ka.aspx. Accessed May, 2007.

[9] L. Cahill, R.J. Haier, J. Fallon, M.T. Alkire, C. Tang, D. Keator, J. Wu, and J.L. McGaugh. Amygdala activity at encoding correlated with long-term, free recall of emotional information. *Proc Natl Acad Sci U S A*, 93(15):8016–21, 1996.

[10] John M. Carroll, Mary Beth Rosson, George Chin, and Jurgen Koenemann. Requirements development in scenario-based design. *IEEE Transactions on Software Engineering*, 24(12):1156–1170, 1998.

[11] Manfred Clynes. *Sentics*. The MIT Press, Cambridge, Massachusetts, 1986.

[12] Toyota Motor Co. Toyota's telematic, telepathic ´pod´ smiles, cries and wags its tail at chicago auto show, June 2002. http://www.toyotaoffroad.com/Articles/Toyota/POD/toyota_pod.htm. Accessed March 2007.

[13] Tamlin Conner. Experience sampling methods: the theory and practice of measuring behavior in situ, 2004. Talk given atYale University Center for Interdisciplinary Research on AIDS (CIRA).

[14] Sunny Consolvo and Miriam Walker. Using the experience sampling method to evaluate ubicomp applications. *IEEE Pervasive Computing*, 2(2):24–31, 2003.

[15] Alan Cooper. *The Inmates are Running the Asylum: Why High-Tech Products Drive Us Crazy and How to Restore the Sanity*. SAMS, Indianapolis, 1999.

[16] Andy Crabtree, Steve Benford, Chris Greenhalgh, Paul Tennent, Matthew Chalmers, and Barry Brown. Supporting ethnographic studies of ubiquitous computing in the wild. In *DIS '06: Proceedings of the 6th ACM conference on Designing Interactive systems*, pages 60–69, New York, NY, USA, 2006. ACM Press.

[17] Andy Crabtree, Terry Hemmings, , Tom Rodden, Karen Clarke, Guy Dewsbury, John Hughes, Mark Rouncefield, and Ian Sommerville. Sore legs and naked torsos: Using cultural probes in dependability research. In *1st DIRC Conference on Dependable Computing Systems*, London, November 2002. Royal Statistic Society.

[18] Mihaly Csikszentmihalyi and Jeremy Hunter. Happiness in everyday life: The uses of experience sampling. *Journal of Happiness Studies*, 4(3):185–199, 2003.

[19] Mihaly Csikszentmihalyi and Judith LeFevre. Optimal experience in work and leisure. *Journal of Personality and Social Psychology*, 56(5):815–822, 1989.

[20] Liyanage C. DeSilva and Pei Chi Ng. Bimodal emotion recognition. In *FG '00: Proceedings of the Fourth IEEE International Conference on Automatic Face and Gesture Recognition 2000*, page 332, Washington, DC, USA, 2000. IEEE Computer Society.

[21] Pieter Desmet. Measuring emotion: development and application of an instrument to measure emotional responses to products. pages 111–123, 2004.

[22] Pieter M.A. Desmet. A multilayered model of product emotions. *Design Journal Alder-Shot*, 6(2):4–13, 2003.

[23] Diana Deutsch. The psychology of hearing, September 1998. Found at http://svconline.com/mag/avinstall_psychology_hearing. Accessed December, 2006.

[24] The Install Doctor. Road and wind noises. document#999503, 2000. Found at http://www.installdr.com/TechDocs/999503.pdf. Accessed May, 2007.

[25] Florin Dolcos, Kevin LaBar, and Roberto Cabeza. Remembering one year later: Role of the amygdala and medial temporal lobe system in retrieving emotional memories. *Proceedings of the National Academy of Sciences*, 102:2626–2631, 2005.

[26] Paul Dourish. Seeking a foundation for context-aware computing. *Human–Computer Interaction*, 16(2–3), 2001.

[27] Paul Dourish. *Where the action is: The Foundations of Embodied Interaction*. MIT Press, Michigan, 2004.

[28] Mattias Esbjornsson. Enhanced social interaction in traffic. In *Studies in Applied Information Technology*, Goteborg, Sweden, 2005. IT-University.

[29] Alois Ferscha and Andreas Riener. The emotional car, March 2007.

[30] Barbara L. Fredrickson. The role of positive emotions in positive psychology. the broaden-and-build theory of positive emotions. *American Psychologist*, 56(3):218–226, 2001.

[31] N.H. Frijda and J. Swagerman. Can computers feel? theory and design of an emotional system. *Cognition and Emotions*, 1(3):235–257, 1987.

[32] Bill Gaver. Provocative awareness. *Comput. Supported Coop. Work*, 11(3):475–493, 2002. http://dx.doi.org/10.1023/A:1021277326673.

[33] Ervin Goffman. *The presentation of self in everyday life*. Harmondsworth : Penguin books, London, 1978. As taken from [51].

[34] Rafael Gomez, Vesna Popovic, and Sam Bucolo. Driving: The emotional experience and automotive design. In *Proceedings Fourth International Conference on Design and Emotion*. Middle East Techical University, July 2004.

[35] Jeremy R. Gray, Todd S. Braver, and Marcus E. Raichle. Integration of emotion and cognition in the lateral prefrontal cortex. *Proceedings of the National Academy of Science*, 99(6):4115–4120, March 2002.

[36] Mohd Hafiz Mohd Hassin, Azizi Ab. Aziz, and Norita Md. Norwawi. Affective computing: Knowing how you feel, 2004.

[37] Jeannette Haviland-Jones, Holly Hale Rosario, Patricia Wilson, and Terry R. McGuire. An environmental approach to positive emotion: Flowers. *Evolutionary Psychology*, 3:104–132, July 2005.

[38] Christian Heath, Jon Hindmarsh, and Paul Luff. Interaction in isolation: The dislocated world of the london underground train driver. *Sociology*, 33(3):555–575, December 1999.

[39] Susan C. Herring, Lois Ann Scheidt, Sabrina Bonus, and Elijah Wright. Bridging the gap: A genre analysis of weblogs. In *HICSS '04: Proceedings of the Proceedings of the 37th Annual Hawaii International Conference on System Sciences (HICSS'04) - Track 4*, page 40101.2, Washington, DC, USA, 2004. IEEE Computer Society.

[40] James Hollan, Edwin Hutchins, and David Kirsh. Distributed cognition: toward a new foundation for human-computer interaction research. *ACM Trans. Comput.-Hum. Interact.*, 7(2):174–196, June 2000.

[41] Willem Horst, Ties Bunt, Stephan Wensveen, and Lisa Cherian. Designing probes for empathy with families. In *Proceedings of the conference on Dutch directions in HCI*, page 15, New York, NY, USA, 2004. ACM Press.

[42] Thomas S. Huang, Lawrence S. Chen, and Hai Tao. Bimodal emotion recognition by man and machine, April 1998.

[43] James M. Hudson, Jim Christensen, Wendy A. Kellogg, and Thomas Erickson. "i'd be overwhelmed, but it's just one more thing to do": availability and interruption in research management. In *CHI '02: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 97–104, New York, NY, USA, 2002. ACM Press.

[44] Scott Hudson, James Fogarty, Christopher Atkeson, Daniel Avrahami, Jodi Forlizzi, Sara Kiesler, Johnny Lee, and Jie Yang. Predicting human interruptibility with sensors: a wizard of oz feasibility study. In *CHI '03: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 257–264, New York, NY, USA, 2003. ACM Press.

[45] Craig R. Hullett, Allan D. Louden, , and Ananda Mitra. Emotion and political cognition: A test of bipolar,two-dimensional, and discrete models of emotion in predicting involvement and learning. *Communication Monographs*, 70(3):250–263, 2003.

[46] Russell T. Hurlburt, , and Sarah A. Akhter. The descriptive experience sampling method. *Phenomenology and the Cognitive Sciences*, 5(3-4):271–301, December 2006.

[47] Hilary Hutchinson, Wendy Mackay, Bo Westerlund, Benjamin B. Bederson, Allison Druin, Catherine Plaisant, Michel Beaudouin-Lafon, Stephane Conversy, Helen Evans, Heiko Hansen, Nicolas Roussel, and Björn Eiderbäck. Technology probes: inspiring design for and with families. In *CHI '03: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 17–24, New York, NY, USA, 2003. ACM Press.

[48] Stephen Intille, Charles Kukla, and Xiaoyi Ma. Eliciting user preferences using image-based experience sampling and reflection. In *CHI '02: CHI '02 extended abstracts on Human factors in computing systems*, pages 738–739, New York, NY, USA, 2002. ACM Press.

[49] Caroll Izard. *Human Emotions*. Plenum, New York, USA, 1977.

[50] Stevi Jackson. Even Sociologists Fall in Love: An Exploration in the Sociology of Emotions. *Sociology*, 27(2):201–220, 1993.

[51] Oskar Juhlin. Traffic behaviour as social interaction – implications for the design of artificial drivers. In *Proceedings of ITS - The 7th World Congress on Intelligent Transportation Systems*. BAS Publisher, 2001. Found at: http://folk.uio.no/potnes/Juhlin.pdf. Accessed May 15th, 2006.

[52] Oskar Juhlin. Beyond just getting there - the interactive road, 2005.

[53] Oskar Juhlin and Daniel Normark-Vesterlind. Supporting bus driver collaboration: New services for public transport managment. In *Proceedings of Intelligent Transportation Systems.*, 2001. citeseer.ist.psu.edu/juhlin01supporting.html.

[54] Oskar Juhlin, Lars-Eric Sjoberg, and Daniel Normark. Road talk informatics - informatics for local collaboration along the roads. In *Proceedings of ITS - The 7th World Congress on Intelligent Transportation Systems*, 2000. Found at: http://www.sts.gu.se/roadtalk.html.

[55] Patrik N. Juslin and John A. Sloboda. *Music and Emotion: Theory and Research (Series in Affective Science)*. Oxford University Press, November 2001.

[56] Jack Katz. *How emotions work*. University of Chicago Press, Chicago, 1999.

[57] Michio Kitamura. Using ubiquitous networks to create new services based on the commercial and public infrastructure. *Nomura Research Institute*, (54), September 2002.

[58] Dirk Knemeyer and Eric Svoboda. Interaction-design.org encyclopedia: User experience - ux, 2005. This is an electronic document. Date of publication: December 28,2005. Date retrieved: May 28, 2007. Date last modified: August 11, 2006.

[59] Igor Knez and Staffan Hygge. Affect in digital game worlds: A self-reported evaluation tool within a multi-disciplinary research context. *Game Aesthetics and Emotion: Light, Sound and Narrative*, December 2002.

[60] Igor Knez and Staffan Hygge. Irrelevant speech and indoor lighting: Effects on cognitive performance and self-reported affect. *Applied Cognitive Psychology*, 16(6):709–718, December 2002.

[61] Igor Knez and Simon Niedenthal. The circumplex structure of affect: A swedish version. *Scandinavian Journal of Psychology*, 42(5):250–263, December 2001.

[62] Jon Kolto. Talking aloud protocol. [Online; accessed 01-June-2007].

[63] Jeff T. Larsen, A. Peter McGraw, and John T. Cacioppo. Can people feel happy and sad at the same time. *Journal of Personality and Social Psychology*, 81(4):684–696, October 2001.

[64] R.J. Larsen and E. Diener. Promises and problems with the circumplex model of emotions. *Review of Personality and Social Psychology: Emotion*, 13:25–59, 1992.

[65] Phil Leather, Mike Pyrgas, Di Beale, and Claire Lawrence. Windows in the workplace: Sunlight, view and occupational stress. *Environment and Bhavior*, 30(6):739–762, November 1998.

[66] J.E. LeDoux. Emotion circuits in the brain. *Annu Rev Neurosci*, 23, 2000.

[67] Gilly Leshed and Joseph 'Jofish' Kaye. Understanding how bloggers feel: recognizing affect in blog posts. In *CHI '06: CHI '06 extended abstracts on Human factors in computing systems*, pages 1019–1024, New York, NY, USA, 2006. ACM Press.

[68] Kristin Leutwyler. Exploring the musical brain. *Scientific American*, January 2001. Found at http://www.sciam.com/article.cfm?articleID=0006255F-8BAA-1C75-9B81809EC588EF21&ref=sciam. Accessed January 20th, 2007.

[69] Kevin Lynch. *The Image of the City*. The MIT Press, Cambridge, Massachusetts, June 1960.

[70] David Matsumoto. Cultural influences on the perception of emotion. *Journal of Cross-Cultural Psychology*, 20(1):92–105, 1989.

[71] Medialink. Protecting drivers from the dark, October 2006. Found at http://www.youtube.com/watch?v=4LIZOGhByQk. Accessed May, 2007.

[72] Bonnie A. Nardi. Studying context: a comparison of activity theory, situated action models, and distributed cognition. *Context and consciousness: activity theory and human-computer interaction*, pages 69–102, 1995.

[73] Bonnie A. Nardi, Diane J. Schiano, and Michelle Gumbrecht. Blogging as social activity, or, would you let 900 million people read your diary? In *CSCW '04: Proceedings of the 2004 ACM conference on Computer supported cooperative work*, pages 222–231, New York, NY, USA, 2004. ACM Press.

[74] BBC News. Racing games breed bad drivers, March 2007. [Online; accessed 02-June-2007].

[75] Physorg.com Science : Physics : Tech : Nano : News. Driving improvements to night vision, June 2005. Found at www.physorg.com/news4543.html. Accessed May, 2007.

[76] Donal A. Norman. *Emotional Design: Why We Love (or Hate) Everyday Things*. Basic Books, May 2005.

[77] Donald A. Norman. Emotion & design: attractive things work better. *interactions*, 9(4):36–42, July 2002.

[78] Andrew Ortony, Gerald L. Clore, and Allan Collins. *The Cognitive Structure of Emotions*. Cambridge University Press, United Kingdom, May 1990.

[79] Mattias Östergren. Sound pryer: Adding value to traffic encounters with streaming audio, 2004.

[80] Mattias Östergren. Traffic encounters - drivers meeting face-to-face and peer-to-peer. In *Proceedings of ITS - The 7th World Congress on Intelligent Transportation Systems*. IT-University of Gotemburg, 2006. Found at: http://www.tii.se/mobility/People/mattiaso-web/thesis.htm. Accessed May 15th, 2006.

[81] Patricia Panqueva. Glowing citizens. *Umeå Institute of Design and the Interactive Institute*, 2006.

[82] Eric Paulos and Tom Jenkins. Urban probes: encountering our emerging urban atmospheres. In *CHI '05: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 341–350, New York, NY, USA, 2005. ACM Press.

[83] Eric Paulos and Tom Jenkins. Jetsam: Exposing our everyday discarded objects, September 2006. Demonstration at UbiComp'06.

[84] Rosalind W. Picard. *Affective computing*. MIT Press, Cambridge, MA, USA, 1997.

[85] Rosalind W. Picard. Affective computing: challenges. *International Journal of Human-Computer Studies*, 59(1-2):55–64, 2003.

[86] Robert Plutchik. *Emotion: A Psychoevolutionary Synthesis*. Harper & Row, New York, USA, 1980.

[87] Alain Priez, Christophe Brigout, Claire Petit, and Lionel Boulommier. Visual performance during night driving. *AARISTE*, 142:541–545, 1998.

[88] Judith Ramey, Ted Boren, Elisabeth Cuddihy, Joe Dumas, Zhiwei Guan, Maaike J. van den Haak, and Menno D. T. De Jong. Does think aloud work?: how do we know? In *CHI '06: CHI '06 extended abstracts on Human factors in computing systems*, pages 45–48, New York, NY, USA, 2006. ACM Press.

[89] William M. Reddy. *The Navigation of Feeling: A Framework for the History of Emotions*. Cambridge University Press, 2001.

[90] Reference.com. Road. (n.d.). Retrieved March, 2007, from Reference.com website: http://www.reference.com/browse/columbia/road.

[91] Harry T. Reis and Shelly L. Gable. Event-sampling and other methods for studying everyday experience. In *Handbook of research methods in social and personality psychology*, pages 190–222. Cambridge University Press, 2000.

[92] Daniel Reisberg and Paula Hertel. *Memory and Emotion*. Oxford Universiy Press, New York, USA, 2004.

[93] Howard Rheingold. *Smart Mobs: The Next Social Revolution*. Basic Books, October 2003.

[94] Marsha L. Richins. Measuring emotions in the consumption experience. *Journal of Consumer Research: An Interdisciplinary Quarterly*, 24(2):127–46, September 1997. available at http://ideas.repec.org/a/ucp/jconrs/v24y1997i2p127-46.html.

[95] Etienne B. Roesch, Johnny R. Fontaine, and Klaus R. Scherer. The world of emotion is two-dimensional, ... or is it?, 2006.

[96] N.E. Rosenthal, D.A. Sack, C.J. Carpenter, B.L. Parry, W.B. Mendelson, and T.A. Wehr. Antidepressant effects of light in seasonal affective disorder. *The American Journal of Psychiatry*, 142:163–170, 1985.

[97] James A. Russell. James a. russell. Found at http://www.bc.edu/schools/cas/psych/meta-elements/pdf/cv_russell_2006_dec.pdf. Accessed April 2007.

[98] James A. Russell. Core affect and the psychological construction of emotion. *Psychological Review*, 110(1):145–172, 2003.

[99] James A. Russell and Lisa Feldman Barrett. Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology*, 76(5):805–819, 1999.

[100] Åsa Blomquist and Mattias Arvola. Personas in action: Ethnography in an interaction design team. In *NordiCHI '02: Proceedings of the second Nordic conference on Human-computer interaction*, pages 197–200, New York, NY, USA, 2002. ACM Press.

[101] Klaus R. Scherer. Emotion as a multicomponent process. *Review of Personality and Social Psychology*, 5:37–63, 1984.

[102] ICBC Road Sense. Waking up to drowsy driving, 2005. Found at: http://www.icbc.com/road_safety/pdf/LP62web.pdf. Accessed May 4th, 2007.

[103] SIKA. Transport and communication policy, 2007. http://www.sika-institute.se/.

[104] Aaron Sloman. Review of affective computing. *AI Magazine*, 20(1):127–133, 1999.

[105] J. Alfredo Sánchez, Norma P. Hernández, Julio C. Penagos, and Yulia Ostróvskaya. Conveying mood and emotion in instant messaging by using a two-dimensional model for affective states. In *Proceedings of the Symposium on Human Factors in Computer Systems*, pages 250–263, Natal, Brazil, 2006.

[106] Ruth Stalker-Firth. Inside your usersŠ minds: The cultural probe. *A List Apart*, March 2007. http://alistapart.com/articles/culturalprobe.

[107] Anna Ståhl, Petra Fagerberg, and Kristina Höök. emoto - emotionally engaging interaction. *Personal and Ubiquitous Computing*, 2004.

[108] Jane C. Stutts, Donald W. Reinfurt, Loren Staplin, and Eric A. Rodgman. The role of driver distraction in traffic crashes. *AAA Foundation for Traffic Safety*, May 2001.

[109] Lucy A. Suchman. *Plans and Situated Actions. The Problems of Human Machine Communication*. Cambridge University Press, New York,USA, 1987.

[110] Sakari Tamminen, Antti Oulasvirta, Kalle Toiskallio, and Anu Kankainen. Understanding mobile contexts. *Personal and Ubiquitous Computing*, 8(2):135–143, December 2006.

[111] Inc. Telematics Research Group. The availability of telematics-enabled autos, August 2002. http://grouper.ieee.org/groups/1616/TelematicsUpdateAugust2002.pdf.

[112] Howard Tennen, Glenn Affleck, and Stephen Armeli. Personality and daily experience revisited. *Journal of Personality*, 73(6):1465–1484, December 2005.

[113] Joachim Tesch, Leonhard Dietze, and L. Miguel Encarnacao. Personal interfaces-to-go: Mobile devices for data exchange and interaction in heterogeneous visualization environments. In *ICDCSW '03: Proceedings of the 23rd International Conference on Distributed Computing Systems*, page 290, Washington, DC, USA, 2003. IEEE Computer Society.

[114] Dictionary.com Unabridged (v 1.1). Road. (n.d.). Retrieved February, 2007, from Reference.com website: http://www.reference.com/browse/columbia/road.

[115] Geetanjali Vaidya. Music, emotion and the brain, 2004. Found at http://serendip.brynmawr.edu/bb/neuro/neuro04/web2/gvaidya.html. Accessed January, 2007.

[116] Noah Vawter. *Ambient Addition: How to turn urban noise into music*. Massachusetts Institute of Technology, Indianapolis, 2006.

[117] Phillip W. Warren. Selected papers (1972-1993) on sentics and manfred clynes.

[118] David Watson and Auke Tellegen. Toward a consensual structure of mood. *Psychological Bulletin*, 98(1):219–235, September 1985.

[119] Mark Weiser and John Seely Brown. Designing calm technology. *PowerGrid Journal*, December 1995.

[120] Wikipedia. Distributed cognition — wikipedia, the free encyclopedia, 2006. [Online; accessed 4-December-2006].

[121] Wikipedia. Ethnomethodology — wikipedia, the free encyclopedia, 2007. [Online; accessed 3-June-2007].

[122] Wikipedia. Experience — wikipedia, the free encyclopedia, 2007. [Online; accessed 28-May-2007].

[123] Wikipedia. Road — wikipedia, the free encyclopedia, 2007. [Online; accessed 13-March-2007].

[124] Peta Wyeth and Carla Diercke. Designing cultural probes for children. In *OZCHI '06: Proceedings of the 20th conference of the computer-human interaction special interest group (CHISIG) of Australia on Computer-human interaction: design: activities, artefacts and environments*, pages 385–388, New York, NY, USA, 2006. ACM Press.

[125] Kikuko Yamawa. Development of the experimental car ‘pod’, July 2002. http://www.its-lectures.ae.keio.ac.jp/2002/2002_b_12e.pdf.

[126] Magdalena Zmudzinska-Nowak. Searching for legible city form: Kevin lynch's theory in contemporary perspective. *Scientific American*, 10(3):19–39, December 10 2003.