INTERACTION DESIGN FOR SUSTAINABLE MOBILITY SYSTEM

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Abstract

This paper presents the results and the methodology carried out by the research group of the Department of Design and Architecture at the Polytechnic University of Turin the field of Interaction Design for sustainable mobility. These two apparently dissociated disciplines found the contact point in a three-year research project between the university and a car company R&D department of the Italian territory: Centro Ricerche Fiat. The cooperation has produced an innovative approach to sustainable mobility and different concepts in the field of Human Machine Interaction (HMI).

Keywords: Interaction, Sustainability, Innovation, Ecodesign, User centred design

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1 INTRODUCTION

Aspects and problems inherent the mobility sector are commonly known. They not only represent a recurring theme in the institutional agenda or in the ordinary matters of many companies, but also they involve everyone very closely every single day.
Even D'Azeglio, a famous Italian statesman lived in the XIX century, highlighted the strategic importance of mobility asserting: “man is born to move, to investigate, to know who he is, what he does and where he goes”. Indeed the story and the progress of humanity coincided with the capacity to move from one point to another one. During these years this need and the increased possibility to move has brought to a complex and intricate system. Today the most recognizable parts of the system are the adverse outcomes as pollution, safety, stress, traffic jams, inaccessibility, inefficiency and so on. Those are the result of linear strategies and projects designed and thought in narrow sectors for many years (Di Salvo et al., 2012). In effect, the mobility system of today is the result of a short-sighted view because it has been dealt with “silos” of knowledge, without giving the right importance to the big picture and the reciprocal relationships between the sector involved in the mobility system.
The recent need to create a low impact and sustainable mobility system have further emphasized the problem of this lack of integration but approaches and considerations are often contradictory. The consequence is a compelling need for new approaches and new tools able to engage a real dialog able to mitigate bad outcomes.
The new "language" requires to consider all the part involved in the mobility system in a broader way with a multidisciplinary and systemic approach in order to answer to new challenges, new dynamics, new needs and new ways of living in modern society.
The answer to this necessity is essentially the aim of this study proving a useful approach able to involve the Interaction Design methods and the emerging technologies in the ICT field towards the sustainable mobility.
This paper presents the result and the methodology of the research work carried out by the research group of the Department of Design and Architecture at the Polytechnic of Turin in the field of Interaction Design for sustainable mobility. These two apparently dissociated disciplines found the contact point in a three-year research project between the University and an Italian Car Company with its Research and Development Department. The collaboration has produced an innovative approach to sustainable mobility and different concepts in the field of Human Machine Interaction (HMI).

2 THE BIG PICTURE: THE MAP OF THE MOBILITY

To identify a unique definition of mobility is hard because the principle itself is hard to delineate. Every movement of people or goods, every involved area and every involved stakeholder should be considered as part of the mobility structure.
Mobility can not only be considered as a complex system, consisting of infrastructures, products and services, that allows something to move physically from point A to point B, but we must also consider it how the system allows access to goods, services, people and information (Litman 2003). Eventually, mobility is revealing a critical factor that influences and affects the development of an area, the quality of people's lives and the conditions of the surrounding environment.
In order to avoid the “silos” trap vision, the research started from a broad analysis of the concept of mobility and on the paradigm of sustainable mobility, trying to define its true nature and its features.
To conceptually simplify and handle all the complex system points of view of the mobility the research group designed a map (in Figure 1) that has been organised with three main drivers: technology, politics and services (Gaiardo, 2011). The map shows then the three main areas in which all the mobility interventions can be divided.
The area of technology includes the development, the implementation and the integration of new technologies, both in mechanical and digital sides, including all the services and products concerning the ICT (Information and Communications Technology) field. The second area of politics and local administrations embraces the urban design and the definition of governance tools for the regulation of the system.
The third area, the service and mode, is driven by the economic and the socio-cultural models that are established in the society. That area influences the choice and the mode of travel of the people and it depends on the habits and the traditions of each territory and context. This map provided us a

horizontal view on the subject allowing us to deal with the HMI automotive field with a global vision of the topic.

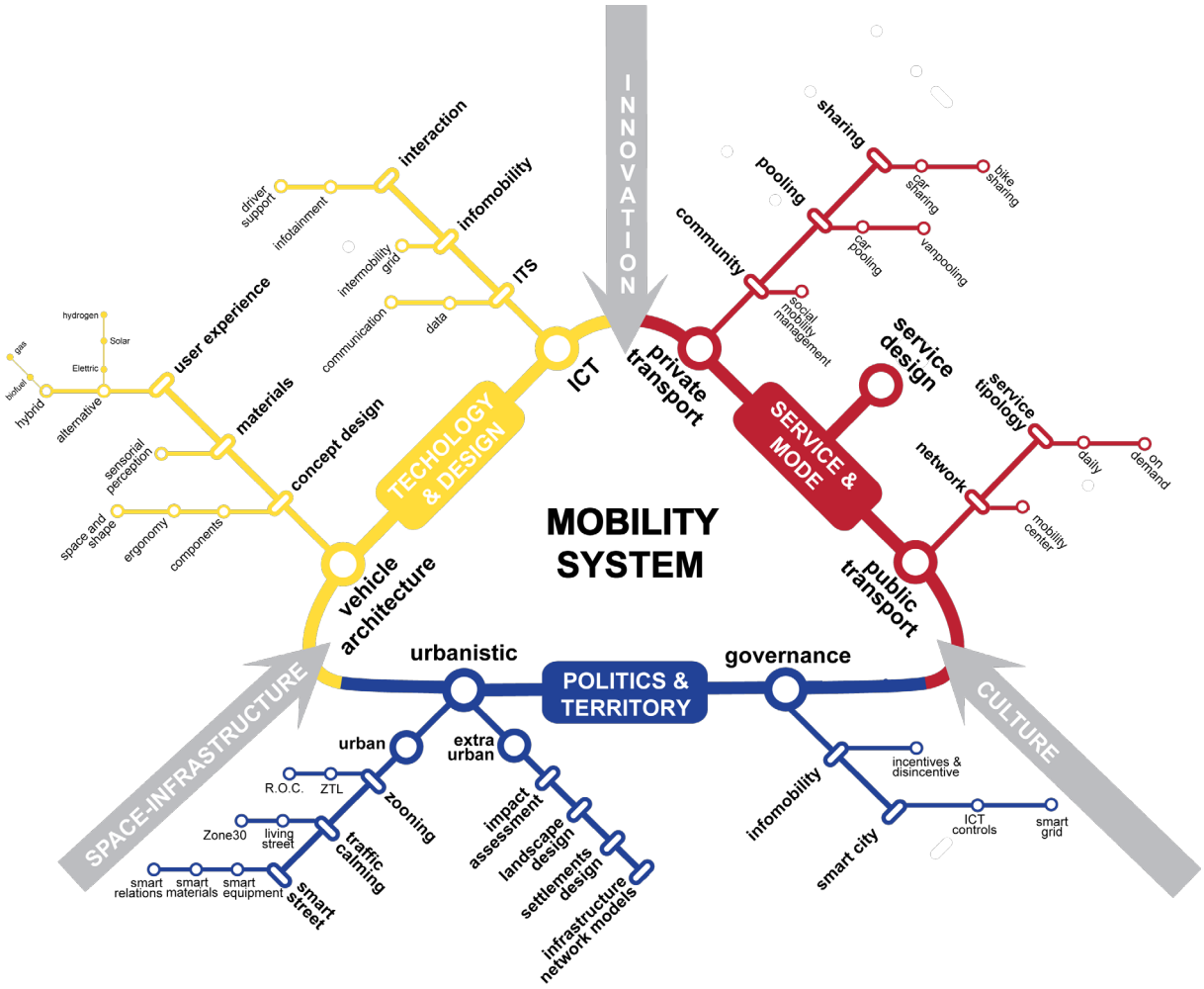

Figure 1. Mobility System Map

2.1 The sustainable mobility approach

Connecting sustainability and mobility is not an easy operation. Indeed, mobility is an essential commodity as is it well explained in the Report on Transport Scenarios with a 20 and 40 year Horizon (Petersen, 2009) "The driving force that creates people's mobility is the search for more opportunities for better living. Under certain natural and cultural restraints, people across history have travelled as far away as transport technology allowed them". Apparently this does not fit with the definition of sustainability given by the World Commission on Environment and Development (Burton, 1987): "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their needs".

These controversial definitions are pulling out a big dilemma: how we could match the basic need of the people to move and the negative consequence of this need? How could we talk about sustainable mobility in term of accessibility without compromising the sustainable aspects?

At this moment, there is not a "silver bullet" able to answer in a proper way to this dilemma. Rather the best answer seems to be a mix of interventions able to deliver positive value and to mitigate the different issue involved in a specific context. So to declare sustainable solutions, we need to consider the balance between the needs of a particular context/territory and its specific cultural, social and economic features (WBCSD, 2001).

The consequence is the adoption of a design approach with a systemic vision able to take into account every result and relationship of the several vertical projects involved in the system in a particular context of intervention. Where the outcomes result from different and multi-disciplinary approach, including new technologies but also a useful human-centred methodology to design them.

Moreover, the adoption of this approach could give as a higher gear. We know that we could influence all the system acting in one of the points of the systems. Interaction design was our focusing point to start to introduce our idea of sustainability in the mobility system.

3 INTERACTION DESIGN AND MOBILITY: THE SCENARIO

In recent years, the Interaction Design (IxD) has been used, or better many stakeholders tried to utilize it, as a design tool to face the sustainable mobility issues. The three main reasons are: the intrinsic relation between new technologies and the connectivity that they own; the possibility of using techniques of persuasion and of communication; the methodological approach that requires a participating involvement of users.
The iterative methodology based on the human needs (Germak, 2008) is well-established and belongs to the multiple disciplines that refer to the design, however, the IxD discipline considers this continuous dialog as its peculiarity and its strong point (Raskin, 2000 and Norman, 2009). As a discipline, it is often regarded as mere application of ergonomic principles, both physical and cognitive, or as a tool able to identify the most common errors encountered in the use or the perception of an artefact. Today, both innovative products and academic research contributions show that this discipline could be more of that. Indeed, IxD is becoming an essential asset for reaching innovative and valuable results in engaging, empowering, connecting, expressing, optimizing and, above all, disrupting projects.
We could see the practice of IxD as the act to create feasible whole with infeasible part. This discipline is more and more becoming an art of finding differences between things that seem similar and the science of finding similarities among things that seem different. The designer role, in that case, is to understand rational, emotional, and cultural dimension of choice and produce a design that satisfied a multitude of function (Gharajedaghi, 2004).

3.1 Participation, Interaction and Mobility: a state of the art.

The way to achieve even just one of these goals undoubtedly lies in the dialog with the user who is often, as in the mobility case, already a user with a considerable amount of experience.
Involving the users consists of listening and interpreting the needs of different stakeholders in order to create a system with data obtained in a holistic way (Bistagnino, 2011). The resulted data are extremely varied cause the complexity of the system and the differences within every territory.
The research team found these peculiarities through questionnaires and reports on Turin mobility. However, there are some common features that highlight a demand of accessibility and reliability of transport mediated by the cost and the travel time as main elements; a need for personal security; an attention to the environmental impact and the public welfare.
The concept of interaction with the mobility was instead interpreted through a perception and vision that are primarily personal. That has generated projects and services mainly characterized by circumstantial and real-time information, thanks to the coming and the support of new technologies. The service providers have used the connection capacity of personal devices (smartphones, tablets etc.) to communicate basic information such as arrival times or available places (in car-parking, bike sharing) or more complex one to plan the move. Some platforms or individual applications have instead tried to connect these clusters of information into different available options. SuperHub (Gabrielli et al., 2013) and GoogleNow (Google, 2012) are indeed interesting examples but approaches, goals, and potentialities are clearly different. SuperHub tries to encourage a change of behaviour, in a sustainable way, suggesting alternative travel modes through the microsuasion (Fogg, 2002); GoogleNow gives all the information and the travel possibilities it knows. The matter of the amount of information and its treatment is, however, essential. SuperHub cannot currently have access to the entire agenda and then to all the movements already scheduled; this factor is impacting in the privacy user, but it is the way to persuade people daily in a tangible way.
Waze (Waze, 2009) and Moovit (Moovit, 2014) are examples of services that come with a bottom-up perspective. These have experienced a rapid spread and proved to be important for the perception of mobility. Both are based on the concept of community that can share relevant information. Waze deals with mobility by car, Moovit by public transport. The strong concept of both concerns the quality: of the time spent in the car; of the cleanliness and punctuality of a bus. In these cases, the interaction has to be considered as the accessibility to data rather than a real interactivity of the service. The apps in

fact, except for Google Now, show evident problems, especially in terms of their operability in motion. Waze, for example, is high attention demanding, it impacts the driving safety and it is not a suitable tools on the move (even the active mobility); that is due to the absence of tangible affordances on the smartphone and its fragility. Therefore, the potentialities of the devices have been explored from the point of view of the connection but underutilized as regards the interaction itself.
The tap and click, core-gesture of most applications, is not in fact the best possible way to interact during the movement. The augmented reality, the strength of some applications, it is not developed to be a support for sustainability. Noteworthy cases that have, instead, relied on interaction and digital technologies are the car-pooling and car-sharing services and peer-to-peer car sharing, as BlaBlaCar (BlaBlaCar, 2014), IoGuido (Tabvn, 2012) and Enjoy (Enjoy, 2014). These services started as web platforms and have been able not only to network stakeholders in order to save money, especially in the medium to long routes, but also favoured the multimodal transport and widespread the paradigm of sustainability that in this case becomes social (as well as economic and environmental).
In this way the interaction becomes apparently crucial for both the design of the service (connecting and engaging), for its management (empowering and optimizing) and during the trip itself, creating, and is one of the few cases, social relations. If the techniques and technologies to connect stakeholders and service are then available, the persuasion techniques, even if well illustrated by Fogg, seem to be still in the experimental stage particularly in regard to complex systems. Current projects are numerous however microsuasion has not a systemic vision because the interaction and its contributions are difficult to quantify.
Specifically the techniques designed for web applications need strategies, joint ventures, and remarkable investments in order to be transported in the system.
The hypothesis of distributing bonuses in the form of discounts or facilitations, as required for example by the citizens, implies not only the agreement between municipalities and service but also a close local coordination and an outlay of money that may not have an immediate return. Instead, furthermore aspects related to interaction and technologies, often included in the acronym ICT, have produced different vision related to mobility.
Proposals based on ICT (SDC, 2010) on the one hand try to change behaviour "on the move" aiming at an improvement and diversification of services, both public and private and the ones called bottom-up; on the other hand they aim instead to a drastic reduction in the need to move. In this period of social and economic transformation, the hypothesis of the reduction in the need for mobility seems to clash with the needs of individuals. On the contrary, they have more and more possibilities to move outside the usual range for work, study, business or personal pleasure reasons. Similarly today, aside from the working issues, the need of moving is familiar to any user.
In addition to the reduction of the need to move, the other common proposed goals for a better mobility are: influence travel mode choice, change driver behaviour, change vehicle behaviour, increase vehicle loading factor, improve the efficiency of transport networks.
The research team decided to look at the feasibility of these common proposals starting with a broad analysis of the instances for a sustainable mobility and the prerogatives and the trends of interaction design. The identified guidelines and the concepts have, therefore, the goal of reducing as much as possible the impact of the use of the means of transportation that today is the main responsible of the transport system adverse outcomes.

3.2 The sustainable HMI automotive scenario.

Inside the automotive system, each car manufacturer is trying to reach a higher level of sustainability (called ECO goals) in its products. In the Human Machine Interaction, they are mainly acting on three aspects: physical HMI, smart HMI, and visual HMI.
A physical HMI is an intelligent mechatronic system capable of mediating the user's inputs, especially on the pedal with respect to the excessive acceleration, thus reducing the negative output of behaviour that is considered as incorrect. The physical HMI even if it is earlier chosen and activated by the driver, however, does not establish a real dialog with the user.
Smart HMI refers to systems, developed mainly for electric and hybrids cars, that can advise and plan intelligent routes (based on traffic, slopes and other parameters very impactful on the autonomy of the vehicle).
The visual HMI provides the driver with information about his driving style in real time and creates statistics that can be consulted on other devices. Until today in the car dashboards and in the

applications related to them, designers made extensive use of green-washing visual languages and information model based on fuel consumption (acceleration, braking, gear changes, and speed) (SDC, 2010). The effort to introduce persuasive techniques also on board is considerable but the results vary like, for example, eco-creatures to be fed (Fiat, 2008); spheres to keep in balance (Nissan, 2010); ratings in the form of stars generated by the on-board computer (Chevrolet, 2010).
Maintaining a driving style careful to consumption is in itself a first-step towards environmental and economic sustainability, but the type of information and the methods used to show it are always quantitative. Interaction is thus considered as an educational tool, although applications start to use some strategies based both on the social (sharing the user's results) and on self-monitoring. However, in the analysed cases the connection to the mobility system and the user's needs is completely lost. The car, in fact, even if it is digital and connected to the network is still separated for example from the personal devices, and then from the peculiar needs of the users.

4 SUSTAINABLE MOBILITY PROJECT: INTERACTION DESIGN GUIDELINES

The team has therefore defined the research field to influence travel mode choice, change driver behaviour, change vehicle behaviour. This area entails the holistic point of view in order to define the following interaction guidelines: adaptability; establish a qualitative dialog; integrated connection; safety.
Adaptability includes a broader meaning compared with word customization. In other words, the driver can choose the driving mode and how the data should be displayed. The car system should be connected also to the personal sphere system and should generate qualitative information based on the needs and the behaviours of the driver in real time. Integrated connection means that the car system should be connected to the mobility system. This guideline has the ambition to manage mobility in real time and on demand. This approach is especially determined to disrupt the habits that users operate routinely, such as the home-to-work travel, to improve the cost-time efficiency for the commuting.
Safety concerns then both the on board one and the perceived one. Interaction and languages should indeed avoid high mental workload during the drive. The perceptive aspect concerns the ability to calibrate information and routes tailored to personal needs.
The research project itself was focused on the design of innovative interfaces for electric and hybrid vehicles, but it has always maintained a vision linked to the system, such as from the premises. The resulting concepts enclose various issues of the car system as they have been designed following the brief and the division of macro themes into subcategories of intervention. The general thread is the approach to sustainability, and it is strongly present in each concept. In the first place the interface should be able to dialog with: the human needs, its devices, the vehicle system and the mobility system.
This shows that the interface should acquire data from the devices (or from the researches made through the personal account with portable tools such as Google Chrome) and sensors that both the devices and the vehicles are integrating in order to monitor the physiological status of the driver. Obtaining and to systematizing all these data is the first step to reach a conscious interaction and, therefore, more oriented towards sustainability.

5 THE PROJECT – WHERE IS THE INTERFACE

The presented concepts can be integrated on-board or programmed for personal device.
The first proposal empowers the existing versions, but it allows a closer and real link to the context. The second proposal is configured instead as an application that can replace the one of the manufacturer or, more interesting case, can be used as the main tool in shared vehicles, making the interface portable. In this case, the concept is designed and scaled to different modes of mobility: on board of any car; active mode (walking, cycling, etc.), on public transport.
The interfaces are different because they have many uses and safety margins. Some of the information, or the application itself can also reside in the cloud, however, for safety reasons the parameters of the vehicle must necessarily remain on board. If the user is operating a tablet or a smartphone as the

central tool on-board, the interaction with the device itself should be limited or mediated by other instruments such as device for the detection of gestures.

5.1 Contest and Interaction

Until now, the provided data is based on correct criteria but far from the real perception such as the amount of CO2 emissions. Users, both those who are already familiar with environmental issues and those who are not, don't have the tools to turn data in a qualitative way. This makes it unintuitive from the point of view of self-monitoring, avoiding to retrace the impact on the system. The projects have instead tried different ways to compare data in order to provide: interactive graphical views; languages and methods of presenting that become tool to communicate, educate and engage the user on sustainability. The centre of the system becomes the information-communication that branches in three complementary approaches: the ecological one, the social one, the security one. Each approach then provides and communicates information about, for example, the dialog with the infrastructure, a vision of the path and planning related to the social interests as in Figure 2. Certainly the primary goals are influencing travel mode choice, changing driver behaviour and changing vehicle behaviour. However, the conveyed message is based on showing how each action, choice and use and can trigger and foster virtuous relationships.

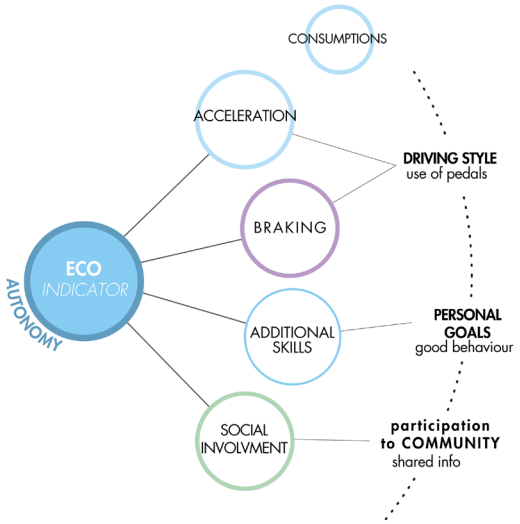

Figure 2. The structure of the eco-indicator

5.2 Tools and Languages

The tool that collects all requests and gives a systemic representation is the Eco-indicator (Figure 3). It is designed for an electric car, so its centre is the visualization of the battery from which symbols and connections branch showing the personal use of the car, own goals, and those of the community of the territory and social participation. The graph, therefore, wants to show that every single parameter can generate a positive impact on the system in the form of links. The more graph is rich and complex the greater participation of the users to the mobility system would be conscious. The graph appears at every start of the vehicle, each time the engine is turned off, for security issues. It can also be examined elsewhere to remind and share the importance of actions.

The designed symbols are intentionally abstract in order to avoid green-washing references and to redraw geometric shapes that are already part of the automotive field. The triangular shape is used, for example, to highlight the parameter of acceleration, the square shape, instead, the braking one. Other tools developed for specific objectives are, for example, odometers and navigators. The odometers are designed to no longer communicate only energy and power but also they educate to efficiency and respect for the rules. This could be done by transforming the tools in order to avoid perceptive positive feedback when the limit has been exceeded. The two concepts in the figure 4 and 5 show, in fact, two solutions. The first one transforms the speed in a symbol of the traffic laws. The maximum reachable speed is set as the full scale (obtained by geo-location) and once reached the odometer will not provide the usual incremental display. In this way, in addition to the quantitative data of the limit it will be perceptually overturned the empowering concept. In fact, it does not derive from the speed or the

engine power but rather from the ability to drive within a range of parameters. Starting from the same assumptions, the second concept blurs more and more data when speed exceeds the limit, in order to communicate a kind of malfunctioning in the relationship between driver, vehicle, and context. This concept can be displayed only in a reversionary mode, its stand-alone visualization in not allowed.
The project provides two areas to divide the messages categories: an H.D.D. that includes numbers and symbols imposed by law, an H.U.D. in which data is shown qualitatively. Among the other developed concepts there are many navigators whose characteristic is the way they consider not only the need to reach a definite point but, above all, they consider interests and needs of users in order to modify or divide the path using the identified P.O.I. on the route. Navigator can report specific locations as well as advise new social ways to move. The travel itself may, in fact, become a chance to meet. The Navigator is also able to mediate the needs of the mobility system, proposing closer charging stations, rather than dynamically interpret the needs of traffic, proposing park & ride solutions, in a more flexible manner. This feature could be useful for changing the established habits especially for daily commuting. The used language is semantically and graphically treated to suit specific users. It switches from the cold and technological one to a colloquial and friendly one, for example, in the case of young drivers. Otherwise in the case of the novice driver the language will be more accurate, with more recommendations given with a higher frequency.

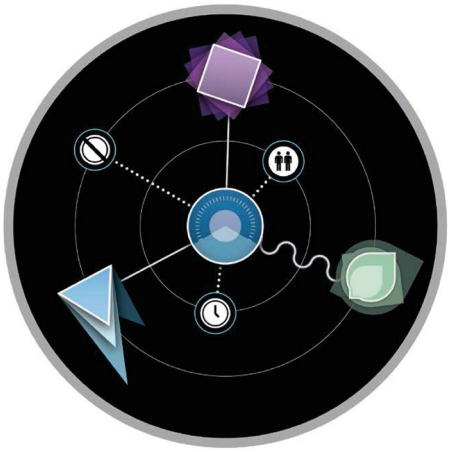

Figure 3. The designed eco-indicator

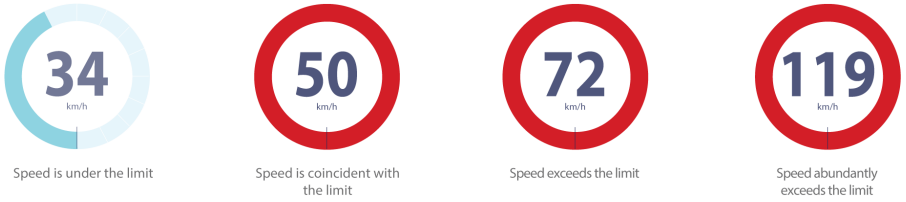

Figure 4. First concept of odometer

Figure 5. Second concept of odometer

6 CONCLUSION AND FUTURE WORK

The aim of the proposed project is to demonstrate how Interaction Design can act as a strategic tool in order to make the mobility system more sustainable. Accessing and working with information and data is an opportunity to provide an innovative visualization and interaction. The interaction can therefore not only educate to sustainability but also establish a new perception link to behaviours and daily habits even inside a car. The presented solutions are a way to transform a purely self-referential field as the automotive sector is. The concepts, therefore, take into account the holistic view but are vertically developed in the automotive industry, for technological and infrastructural reasons. For this issue, next steps of the research will be directed towards more real connections between the actors of the system, services, and infrastructures.

REFERENCES

Bistagnino, L., Systemic Design, designing the productive and environmental sustainability / Design Sistemico, progettare la sostenibilità produttiva e ambientale, 2a ed. (ebook), Slow Food Editore, Bra (Cuneo) 2011

BlaBlaCar (2014), On line car-pooling platform. Available at www.blablacar.it [Accessed 13 December 2014]

Burton, I. (1987). Report on Reports: Our Common Future: The World Commission on Environment and Development. *Environment: Science and Policy for Sustainable Development*, *29*(5), 25-29.

Chevrolet, 2010, http://www.chevrolet.com/volt-electric-car.html

Di Salvo, A., Gaiardo, A., & Ermacora, G. (2013). MobIoT: sustainable social mobility in the Internet of Things. Management of Technology-step to sustainable production, Novi Vinodolski, Croatia.

Enjoy (2014), On-line peer to peer car sharing platform. Available at https://enjoy.eni.com/it/ [Accessed 13 December 2014]

Fiat, 2008, http://www.fiat.com/ecodrive/.

Fogg, B. J., Cuellar, G., & Danielson, D. (2002). Motivating, influencing, and persuading users. *The human-computer interaction handbook: fundamentals, evolving technologies and emerging applications, L. Erlbaum Associates Inc., Hillsdale, NJ.*

Gabrielli, S., Maimone, R., Forbes, P., Masthoff, J., Wells, S., Primerano, L., Haverinen, L., Bo, G., Pompa, M., 2013, Designing motivational features for sustainable urban mobility in CHI EA '13 CHI '13 Extended Abstracts on Human Factors in Computing Systems, Pages 1461-1466, ACM New York, NY, USA ©2013

Gaiardo, A. (2011) *Sustainable mobility roadmap*, Master thesis, Polytechnic University of Turin, Turin

Germak, C. (edited by), Uomo al centro del Progetto - Man at the Centre of the Project, Allemandi, Torino 2008

Gharajedaghi, J. (2004) *System Methodology. A Holistic language of interaction and design.*

Litman, T. (2003). Measuring transportation: traffic, mobility, and accessibility. *ITE Journal*, *73*(10).

Moovit, 2014, http://www.moovitapp.com/

Nissan, 2010, http://www.nissan.co.uk/GB/en/YouPlus/welcome_pack_leaf/eco_virtual_trees.html

Norman, D. (2009) The Design of Future Things, Basic Books

Petersen, M. S., Sessa, C., Enei, R., Ulied, A., Larrea, E., Obisco, O., ... & Hansen, C. (2009). Report on Transport Scenarios with a 20 and 40 year Horizon, Final report. *Copenhagen: funded by DG TREN.*

Raskin, J. (2000) The Human Interface, New Directions for Designing Interactive Systems, Addison-Wesley Professional

Sustainable Development Commission, 2010, Smarter Moves: How Information Communications Technology can promote Sustainable Mobility, London.

Suen, S. L., & Mitchell, C. G. B. (2000). Accessible transportation and mobility.*Transportation in the New Millennium*.

Tabvn, (2014), Turin car-sharing website. Available at http://carsharingtorino.it/[Accessed 13 December 2014].

Waze, 2009, https://www.waze.com

WBCSD (2001) Mobility 2001: World mobility at the end of the twentieth century and its sustainability, Conches-Geneva.