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From Building Cars to Selling Ubiquitous Computing Systems

A Socio-Technical Approach towards Connected Cars in Light of Human-Computer Interaction

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ABSTRACT

The automotive industry is undergoing a technological revolution with the development of Connected Cars. The empowerment of in-vehicle Ubiquitous Computing (UbiComp) does not only shape drivers' behaviour but is also shaped by the drivers' psychology. Drawing on academic literature, this paper will show that acceptance and success of UbiComp in the context of the Connected Car is dependent on social norms and behaviours. Major components such as security, privacy and the loss of autonomy need to be taken into account when modelling a Connected Car. In conclusion, the ongoing changes and trends towards connected cars can only be successful if Original Equipment Manufacturers (OEM) address socio-technological questions to smoothen a social adaptation to the driver and its environment.

Introduction

In the past, technological advances have dominated the automotive competition. Today, the competitive landscape, widely driven by connectivity of vehicles, is rapidly changing. The Connected Car or the so-called Smart Car has a two-side optimizing approach: it is "able to optimize its own operation and maintenance as well as the convenience and comfort of passengers using on board sensors and Internet connectivity" (McKinsey, 2014). McKinsey (2014) has estimated that the value of connectivity components and services will have increased from €30b to €170b in the global automotive sector by 2020. This drastic change was caused by UbiComp combining network technologies with Internet capability, sensor networks, human computer interaction and artificial intelligence (Mai et al, 2011). Integrating new stakeholders such as software and telecommunication firms into the automotive market challenges the OEMs: They have to secure control over these technologies and dispel consumer's doubts of both insecure information flow and the loss of social interactivity and autonomy. In order to do so it is crucial to understand how the change of this digital business model influences vehicle drivers and its society (Sandhu & Thomas, 2004).

This paper seeks to analyse Connected Cars within the issue of social interactions and information control flow by using a socio-technical approach. Since driving a Connected Car is intertwined into the human daily activities, it is important to address socio-technical issues of UbiComp into a larger social setting relating to sociological, cognitive, economic and legal aspects of our lives (Sandhu & Thomas, 2004). The socio-technical perspective will thus integrate the significance of human attitudes and behaviours towards UbiComp innovation by going beyond a system-centric technical/rational perspective (Avgerou & McGrath , 2007).

First, I will commence with reviewing literature on the effect of UbiComp concerning social acceptance and integration. Hereby it becomes apparent that fundamental sociological drivers are positively and negatively correlated in the context of Connected Cars. I will then elaborate on the changing process of human-computer interaction. Thirdly, the reciprocal levels of social interactions within human-computer systems will be examined: *configuration* and *implementation*. Within those two levels, socio-technical key drivers for the adaptation of Connected Cars will be defined. Lastly, I will feature limitations of my analysis regarding technical and rational aspects.

Literature Review: Social acceptance and integration of UbiComp

Smart objects are integrated into our daily life (Sen, 2012). They have been an area of research not only in the technological field but also in the domain of encompassing sociology. Technology is becoming more and more capable and pervasive within the

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automotive industry. This is gradually leading to the socially complex question of how to appropriately integrate the new car's capabilities within the driving experience. At this, a main focus is to be found in the question of how to deal and to cope with autonomy and trust, privacy and security profiles, social interactivity, efficiency and enjoyment (Stanton et al, 2001).

According to Marsden & Stanton (1996), UbiComp increases efficiency because the focus changes from physical control and driving to a more cognitive task, a "supervisory control" for the human being. This results in the enhancement of the driver's attention and of the monitoring management skills as well as in the improvement of his or her situational awareness (Endsley, 1995). Moreover, the pervasive and permanent feedback system of a connected vehicle ensures a "closed-loop behaviour" (Annett & Kayl, 1957) whereby the immediate action-feedback setup creates the most effective performance and learning curve for the driver (Stanton & Young, 1998). Due to higher efficiency, Stanton et al (2001) argue that UbiComp increases the enjoyment of driving a vehicle as this is dependent on social-psychological variables such as the driver's feedback, perceived safety and time urgency.

Conforming to Hongladarom (2013), sharing and distributing information with other entities such as drivers or car maintenance stations creates a faster empathy between entities and thus between human beings. As a result, boundaries to the "outside world" will constantly be reduced. Sandhu & Thomas (2004) even take a step further by categorizing this un-restrictedness as the new concept of dynamic trust relationships in which anonymous identities are dependent on communication.

Contrary to this, McCaulder et al (1997) argue that UbiComp puts too much trust and autonomy into Connected Cars. Since vehicles are empowered, drivers neither feel full responsibility nor full control anymore. This external "Locus of Control" (Parkes, 1984) arises in the wrong perception of individuals attributing malfunctioning and failures to technology which result in events such as accidents. This "over-trust" can lead to the overuse of technology, lower intervention and eventually to the loss of autonomy (McCaulder et al, 1997).

Opposed to Hongladarom, West (2011) believes that this inter-connectedness has the potential to decrease social activity. Since human nature is less familiarized with computer-machine interaction, it might trigger negative reactions towards communication with other entities.

Lastly, privacy and security profiles will influence social acceptance. According to Sen (2012), the mistrust of secure data protection is very high since a vehicle is not a "trivial or fun application" like a smartphone. Because of the large amount of smart entities and the uncontrollable spontaneous network, human beings are socially reluctant to this non-transparency, especially because a driver needs to fully trust the car.

Therefore, one can argue that social context and behaviour will influence the acceptance of in-vehicle connected capabilities. Due to the emergence of connected features and entities, OEMs and their stakeholders have to use a socio-technical lens to derive the right innovation in the automotive industry (Avgerou & McGrath, 2007).

The Changing Process of Human-Computer Interaction

"The most profound technologies are those that disappear. They weave themselves into the fabric of every day life, until they are indistinguishable from it" (Weiser, 1991). Taking this quote as the crux of the matter, a real path of generation-evolution concerning UbiComp can be traced. The first generation, which can be roughly placed between 1991 and 2005, was driven by the idea of an omnipresent and absolute connectedness embracing the emerging availability of technology (Connectedness). The goal of creating and implementing autonomous systems was achieved by literally connecting everything to everything. The first phase was followed by the second generation focusing on the so-called awareness (Awareness, 2000-2007). The former focus on the overall-connection had shifted to an overall-awareness, including context-awareness, resource-awareness, and, eventually, self-awareness. Based on this heritage of both, connected awareness and aware connection, the third generation (Smartness, from 2004 on) attempted to finally allocate a meaning to situations, actions and circumstances. The main focus was (and still is) to create intelligent, smart, highly complex and diversely-structured systems that would and will, to speak in Weiser's words, be indistinguishable and be part of a silent integration. (Davies et al, 2011)

From a socio-technical perspective, autonomy has been undergoing constant changes in the course of the above stated generations. Precisely spoken, autonomy is a two-sided term which shall not be restricted to the generally found unilateral definition: It can be referred to as the ability to construct one's own goals and values as well as to have the freedom of taking one's own decisions (Davies et al, 2011). Additionally, autonomy means monitoring, controlling and optimizing in order to allow smart and connected technologies a maximum of control. The third generation has been accompanied by a drastic and bipolar change regarding autonomy (Porter& Heppelmann, 2014). Whilst the autonomy in terms of knowledge-based monitoring, analysing and planning has constantly increased and finds itself on the verge of (semi-)absolute autonomy, the autonomy considering the exposure of data and personal information is constantly decreasing.

In fact, it is not only the above stated profound technology which disappears gradually. At the same time, the autonomy regarding the control of exposed personal data vanishes, whereas the autonomy in terms of technology increases. This correlates with an increasing awareness of privacy and the reluctance

of today's "generation connected" to give personal information away (Sen, 2012).

With regard to Connected Cars, attention shall be drawn to external and internal social factors, which are crucial of how UbiComp might shape the future generation.

Shaping Connected Cars in the Process of Social Acceptance

When it comes down to the process of acceptance of Connected Cars, one has to distinguish between two interacting, interdependent and communicating levels: *configuration* and *implementation*. Regarding the *configuration* procedure of this digital business model, two major *external* factors are decisive. Firstly, a successful configuration demands for a regulation of personal information, the protection of security and a careful information management. Secondly, the already mentioned loss of autonomy, which results from this digital business model, requires a careful approach in terms of individual preferences and moral principles.

Once the configuration of Connected Cars has been completed, two major *internal* effects can be seen from this digital business model when it comes down to its *implementing* into the society. In other words, one can conclude that only the interplay between external configuration-factors and internal implementation-factors allows a complete understanding of the *'seat of the matter' ('sedes materiae')* and is the keystone for a successful and accepted multidisciplinary implementation. (Porter & Heppelmann, 2014)

Security matters, and so does privacy. A global survey stated that nearly 90% of people are worried about the exposure of personal data (Spiekermann, 2012). This fear originates from the danger being unavoidable linked to such a ubiquitous business model. A huge amount of information is generated and stored in several, mostly unknown and unreachable data storages and sources. With an increasing amount of heterogeneous data from a variety of sources, the complexity, the reproducibility and also the quality of the stored information increases (Conti et al, 2012). Besides car-relevant information, consumer-based and thus sensitive information is gathered on a long-term availability base. As a result, the idea of so-called "movement patterns" arises from a socio-technical point of view. A huge set of data might result in a very fine and personal recreation of the consumer's profile. For this reason, the complexity of the fictional cyber world calls for a modification in the way humans share information (Conti et al, 2012). In Europe, the European Data Protection Directive 95/46 EC is a first step towards the (careful and attentive) regulation of private information flows. This Directive demanding for a national transposition requires e.g. a purpose specific processing, transparency vis-a-vis data subjects (with a consent possibility), the right of information and complying with data subjects. In addition, it ensures the confidentiality and security of personal data and norms rules for its safeguarding. The directive is both a legal and especially a socio-cultural expression of an underlying desire and need: Extended UbiComp demands for a well-designed infrastructure showing consideration of this privacy issue. If this configuration factor is taken into careful consideration, a positive benefit results in two effects. The configuration of Connected Cars equals with its acceptance. Thus, the regulation of private information data includes advantages for the automotive industry such as a better understanding of customers' needs and demands, a more appropriate customer service, the development of a Car Lifecycle Concept and a higher utilization of facilities such as repair shops (Bajic & Chaxel, 2002). Second, the consumer itself prefers "being liked matters". Especially the "generation connected" is highly influenced and influenceable by the community and online friends. Thus, they "trust the wisdom of the crowd" (Bai & Krishnamachari, 2010) which can also be described as the generation "we-feeling", especially once the protection and regulation of safety issues is assured.

Besides security, another factor is essential from a socio-technical perspective: the loss of autonomy. Having already been mentioned, the philosophical ideal of autonomy, which is strongly related to the principle of freedom, has long been defended as a main goal of our society. A UbiComp model such as Connected Cars curtails this aspect of self-governance from various aspects. In order to guarantee a flexible and need-satisfying digital business model, the ability among the technical devices and their feature of adapting to any occurring automotive scenario is crucial. For this reason, Connected Cars demand for a self-managing, self-adaptive, self-executing and self-executive system, preventing the customer from staying in the control loop (Conti et al, 2012). This lack of autonomic behaviour can but does not have to be a negative aspect. In fact, the aim of a successful configuration is to bridge the gaps and to "pave the way" in terms of a lacking autonomic behaviour. Additionally, a so-called loss of autonomy can be considered a gain of a different form of autonomy at the same time. First of all, being autonomous implicates the possibility of equal input into moral principles, which can be considered the reflection of individual preferences (Brey, 2006). Self-governance is thus inseparably related to self-realisation (Dworkin, 1988). Therefore, individual autonomy is the breeding ground for all personal developments. However, this does not mean that a lack of autonomic behaviour is negatively connoted: a loss on one side can be considered a gain on another side. Firstly, UbiComp only means a delegation of control (Brey, 2006). The control of the delegated matter is still an autonomous action, even perhaps a more complex and more demanding form of control. Secondly, a general "loss" of autonomy generates and nourishes the just developed "we-feeling" and thus only changes the breeding ground, not the fundamental ethical question of human autonomy.

As a result, one can conclude that a socio-technical approach demands for a ubiquitous service to be tailored to both, the user's context and its requirements and especially needs to take care of the privacy issue

and the shifted, simply modified need for a control of (delegated) autonomy.

Socio-Technical Repercussion on Human Being and Social Behaviour

The implementation of the framed and tailored digital business has two major effects on the human being and its behaviour. The alteration from a rigid to a flexible, service-on-demand model introduces a new medium. Speaking in the metaphor of an ecosystem, the implementation of a UbiComp system is nothing less than the creation of a new system with new players and new restrictions, new boundaries, new value chains and new components (Mai et al, 2011). Since the OEM-software holds ultimate responsibility for the safety of their products and services, a trespassing protection throughout the system is insured allowing different participants of the business system the same treatment. One effect is the change of form. The indirect contact with customers through mass-market advertising is gradually replaced by a direct marketing strategy through apps and services to customer (Komninos & Zaharakis, 2012). The main effect of the implementation is the increasing brand-loyalty due to improved consumer behaviour patterns and a more valuable and more customer-need-based vehicle marketing. Additionally, an innovative on-demand service, a customer care and aftersales-service as well as infotainment result from it (Capgemini, 2014).

From a socio-technical view, the modified interaction with the human being does not deprive him or her from taking autonomous decisions, but instead focuses on a higher-level task (Brey, 2006). As a result of more closely-supervised and existing data samples, all of them within the legal boundaries, UbiComp can make it easier for human to achieve certain goals, destinations and to react to certain (unexpected) situations. In other words: By requiring less physical and thus more cognitive effort, the human environment can be considered a more controllable environment. Nevertheless, one should bear in mind that any "control ideal" is connected to the danger of losing its own smartness. This is so because any UbiComp can become paradoxically reverted: "Devices and applications which have become physically unobtrusive, could turn out to be psychologically obtrusive" (Gupta, 2002).

Limitations and Future Research

This paper contributes to the socio-technical perspective of OEMs towards the acceptance of Connected Cars in society. I have offered an approach in which the interplay between external configuration-factors and internal implementation-factors will forge the success of this digital business model. However, it does not address any rational key success factors. Technological prerequisites such as a powerful wireless connection system might not be found in all parts of the world. An example is China, where rural areas struggle with an operating wireless connection system. Furthermore, I have not addressed mobility management in the area of technical aspects such as algorithms and non-compatible software. Even though this paper focuses on the acceptance and sociological consequences of customers, it leaves out the elaboration of the customer's willingness to pay for additional features within the connected system.

Conclusion

The carefully-balanced interaction of internal and external factors is essential for the understanding of the human behaviour in its sociocultural context. Thus, the complexity and the shown demand for the implementation of a digital business model require the development of self-organized strategies. In this context, the question regarding the nature of this environment can be located. One may wonder what will come next after the generations of connectedness, awareness and smartness? It is likely that the multidisciplinary endeavour will result in a generation of "absolute autonomy", a system in which smart, aware and (inter-) connected products can function in full autonomy (Heppelmann et al, 2014). Likewise, it shall be possible that we find ourselves on the edge of a parallel cosmos (Conti et al, 2012) in which the physical world being populated by tangible entities is connected via UbiComp as a connective link to the cyber world consisting of compromised data.

As Milon Gupta has phrased it: "In a way, it is quite a relief to know that all things in your home (...) are dumb. They give you the feeling that you are always in control. This feeling is in danger, if (they) suddenly turn smart." Great efforts in both technology development and social policy will be necessary. As long as the ethical issue of privacy is carefully considered, Weiser's statement considering the process of invisibility can be modified as the follows: With the right social adaptation and in consideration of the driver's consent, ethical rights and the need for certain - visible and thus controllable - privacy regulation, the ubiquitous system will be a major part of OEMs in the future.

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