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Applied Agency: Resolving Multiplexed Communication in Automobiles

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ABSTRACT

We explore the transition to greater sociability concerning automobiles in the context of communications being more fully integrated into their systems. We briefly examine the historical significance of past social technologies in cars and the relationship between synchronous and asynchronous communication technologies in the present. In particular, we examine the consequences of the emergent network that results from interaction between drivers, passengers, pedestrians and locations we call PolySocial Reality (PoSR), a conceptual model of the global interaction context within which people experience the social mobile web and other forms of communication. Based on this discussion, we suggest ways to enable more robust messaging in this context with a recommendation to enhance the agency and social awareness of software agents.

Categories and Subject Descriptors

H.1.2 [**Human Factors**]: Human information processing; J.4 [**Social and Behavioral Sciences**] Anthropology; B.4.3 [Interconnections (Subsystems)]: Asynchronous/synchronous operations; K.4.1 [**Public Policy Issues**]: Transborder data flow; K.4.3: [**Organizational Impacts**] Computer-supported collaborative work

General Terms

Design, Reliability, Security, Human Factors, Standardization, Theory.

Keywords

Automobiles, Social Media, Asynchronous communications, PolySocial Reality, Mobile Devices, Human Factors, Anthropology, Privacy, Security

1.INTRODUCTION

Early streets were inherently social, without automobiles. Although history would like to portray the introduction of automobiles to city streets and country roads as a friendly integration – early automobiles were rather anti-social to street life, often causing great divides between the public, who felt they had a right to streets, and automobiles, whose speed and power took them over. In part, this phenomena is illustrated by a montage of early clips from Harold Lloyd's 1928 film, 'Speedy.'[1]

The sociability of humans around automobiles at their beginning was that of being in conflict. People had opinions and fights regarding access of public streets and many tried to introduce legislation to protect themselves against automobiles [1]. This is echoed most recently in automobile/mobile phone regulation legislation where cars on the street play the part of the norm that is being taken over, and made more dangerous by those using mobile phones while driving. Today, we're designing embedded telecommunications technologies into the car, and in the process, making the car itself, in its entirety, a communications device. As to be expected, similar types of debates from history are being considered and opposed as were in the past. The ability of mobile technology to allow for both asynchronous and synchronous communication, without much of a noticeable time delay has resulted in multiple multiplexed communications scenarios. Our model of this is called PolySocial Reality (PoSR). In this paper, we explore the impact of PoSR on the next layer of integration of the automobile as a communications device in society, and in particular the need to develop software for the social automobile that encapsulates a concept of agency on the part of drivers and other automobiles.

The idea of a 'socially inspired' car is not new. Indeed, in the early introduction of automobiles, as documented by photos and films, cars were often set within highly social contexts: groups of people were called upon to right cars that had driven off the road, or that stalled in traffic and needed a crank to restart.[2] Automobiles that had running boards along their sides, invite youngsters to hitch rides down city streets.[3] Not everyone had a car, and in the early

[1] Driving Around New York City – 1928. Clip of scenes from Lloyd, H. (1928). Speedy. Uploaded by Aaron1912. Available from: http://www.youtube.com/watch?v=lkqz3lpUBp0 Accessed: October 5, 2012

[2] Old car. (2008) Photo of car being righted in 1930's. Uploaded by Darth Bengal. Available from: http://www.flickr.com/photos/darthbengal/3053814313/in/photostream/ Accessed: October 5, 2012

[3] Car-Surfing. (1932) GrandView Michigan, This Week Magazine, July 1932. Available from: http://www.ghmchs.org/ thisweek/photo-listing_files/car3.jpg Accessed: October 5, 2012 thisweek/photo-listing_files/car3.jpg Accessed: October 5, 2012

accounts, people were shown to share and help each other by offering rides or running errands for those who were not as fortunate. Many early vehicles had open tops that were shown to encourage driver-to-driver communication, or communication with others on the city streets and sidewalks.

What really happened was much less idyllic: people fought automobile owners and drivers for control over the public streets and subsequently lost. It was a highly social process, but not social in the way that the streets were before automobiles. It was social in terms of conflict, opinion, discussion and politics, and was not necessarily polite, cooperative or peaceful.

> By the turn of the nineteenth century, streets were already shared by several sociotechnical systems. Private, horse-drawn vehicles and city services depended on them. Pedestrians, pushcart vendors, and children at play used them as well. The balance was always delicate and sometimes unstable, and crowds of automobiles soon disrupted it. During the 1910s and 1920s competitors fought to retain, or establish, legitimate title to the streets…Of the many street rivalries, the feud between pedestrians and motorists was the most relentless—and the deadliest. Blood on the pavement often marked their clashing perspectives… Their success or failure reflected not only the opinions but the fortunes of those who used them. Pedestrians forced from the street by aggressive motorists blamed the problem on spoiled "joy riders," and were in turn dismissed as boorish "jay walkers" by irritated drivers. [2:332]

Although at times unpleasant and at others deadly, this type of social communication shared a common trait: it was synchronous, happening in real time with people interacting in the same way. As cars were able to go at higher speeds and had a more robust architecture, they closed off and became even less social with the community (good or bad) outside their exteriors. Eventually, telecommunications devices became robust enough to be mobile. Radio phones, then Citizens Band (CB) radios, followed later by mobile phones entered the car environment and re-connected those inside vehicles to others outside their cars, who may or may not have been either on the road (as with CB radios and possible mobiles) or on land lines. In particular, the early days of CB radio had many parallels to the issues today of creating a 'socially inspired car.' According to Dannefer and Poushniky, CB radio usage created an anonymous, private (by anonymity), extended social network that gave people confidence that they could get access to help, traffic information, weather, police activities, etc. through communications with other members of the network. Anyone could purchase and use a CB radio, and while there was always the potential for criminal activity or betrayal of trust, it did not inhibit people from using the network. Trust was implicit by both having a CB and being a "Good Buddy" [3].

> The CB technology facilitates the expression of closeness, but it prevents its natural concomitant of commitment. This is so because the constraints placed upon behavior in repeated face-to-face interaction situations are absent. The overall impact of the technology has been to create a facade of strong social ties. Unfortunately, the social network thus produced is fragile. [3:616]

While CB radio communication was tenuous, due to its anonymous nature and lack of face-to-face interaction, it also happened only in synchronous time. The addition of mobile devices to the car enabled both synchronous and asynchronous communications, as well as documentation of where the call originated from, duration and so on. This removed privacy somewhat, but increased the robustness of trust. As phones became message enabled, communication between people using mobile or telephony technologies became more asynchronous and people communicated in a way that was time shifted, aided by the ability to send messages out with no knowledge of when they would be received or replied to and/or retrieve them at their leisure.

2.SOCIAL AUTOMOBILES

2.1The Socially Inspired Car

The 'Transition to the Socially Inspired Car' might be titled the 'Return to the Socially Inspired Car' as we revisit and reinvent sociability through technologically assisted transportation. Sociability has different forms and at its foundation extends beyond our ability to communicate with one another to be social. Sociability is part of our survival strategy. To survive, humans must remember their dependence on each other for existence. Edward T. Hall wrote, "Man and his extensions constitute one interrelated system," [4]. As much as we'd like to separate that which is 'social' from that which is in the environment, we cannot, for these are interdependent [5].

Cars and people are already part of a highly complex interrelated social system that includes the infrastructure that they are dependent upon. This interactive social structure creates and maintains the systems that enable cars to function: streets and road repair, fuel, rubber for tires, oil, glass, metal, paint and other industries combine to make the idea of a running car even possible. When one is isolated in a comfortable car moving down a beautiful road, it is unlikely that the social structure required that makes the drive possible is even considered by the driver. If we add the potential for synchronous or asynchronous message communication to that driving experience, we can see that the interrelated social systems can get even more complex.

2.2PolySocial Reality

We have suggested PolySocial Reality (PoSR) as a term for the conceptual model of the global interaction context within which people experience the social mobile web and other forms of communication [5;6] (see Figure 1.) PoSR describes the aggregate of all the experienced 'locations' and 'communications' of all individual people in multiple networks and/or locales at the same or different times. PoSR is based upon the core concept that dynamic relational structures emerge from the aggregate of multiplexed asynchronous or synchronous data creations of all individuals within the domain of networked, non-networked, and/or local experiences [7].

As an interaction context, PoSR has positive and negative outcomes. A potentially positive outcome may be an expanded social network; a negative outcome may be that those expanded social networks are connected by small, single dimension attributes. Another may be that the fragmentation of PoSR encourages individuation, which makes it more difficult for humans to be social (and cooperative) with one another, even as they effectively have a larger social network. While implementations continue to focus on individuated orientations, this can further compound that problem.

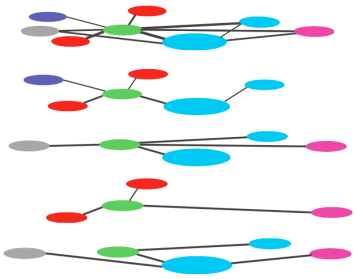

Figure 1. An 'exploded view' of a fragment of a PoSR network. Each layer represents a different social network of the same individuals, each based on a communication channel.

To the extent that people share common sources of information while interacting with each other, the greater their capacity to collaborate becomes. If they share too few channels relevant to a common goal, there may be too little mutual information about a transaction to interact and communicate well collaboratively. Poor collaborative interaction can lead to further relational fragmentation with the potential to promote individuation on a broad scale [8]. By changing the means that humans use to manage space and time during their daily routines, developers can shift our experience from individuated, user experiences to enhanced sociability within a multi-user, multiple application, multiplexed messaging PoSR environment.

If we consider the idea of PoSR in an automobile, we have multiple channels creating multiple communications, which may or may not be multiplexed, and receiving multiple communications in kind that may or may not be synchronous, all while moving, it can add up quickly to being overwhelming. This is evidence by the issues that have been legislated around the world regarding behavior in phones and driving, texting and in some cases even holding, a mobile device [9;10].

2.3 The Connected Car

Imagine someone driving on the road in a 'connected car.' They are being assisted by various on screen windshield AR applications that guide them through traffic, map their route and suggest places to stop along the way that they might want to visit. Furthermore, they still have the capability to make and answer calls, tell an agent how to respond to email etc. all while in-motion. They might be drinking a coffee or having a snack as well [11]. But that is not all of the challenges for the near future driver.

The battle for the territory for the car and its digital interior has just begun. In her essay, 'Connected cAR: Becoming the Cyborg Chauffeur,' the first author suggests that the way that cars are automating may be using human behavior to train the Artificial Intelligence (AI) of the car. At present, a human is still needed for nearly all automobiles and may start to be training the system as to the parameters of driving behavior.

The car is apparently one of the next battlefields for ownership of our personal data and privacy. It is an intimate environment and there will soon be enough sensors to document every human habit and behavior within it. While cars will become the panoptic reporter to our every move, people will also be burdened with an overwhelming amount of data ostensibly aimed at 'aiding' them in the driving task. There will be touch activated windshields, Augmented Reality (AR) navigation lines projected onto the windshield that guide drivers on a track of navigation, and the blending of both scenarios with the addition of ads showing up on screen. Audio feedback based on sensor activity is currently available as a service in certain commercial vehicles. Installed sensors monitor driver behavior and provide immediate audio feedback if a driver changes lanes suddenly, is speeding or engages in other unsafe behaviors [11].

While an audio warning to remind people that their cars are weaving is useful, it does not fully address the issues that are required to keep cars safe with a multiple menu of digital, technological, and social options soon at their command. Cars are going to have to provide tools that simplify the decisions that both people and cars need to make to keep the car safe – if nothing else.

Sharing, or making a car more 'social' is certainly a double-edged idea. In one way, it can be similar to what happened in the later days of the automobile (after the turf wars for the streets had subsided) where 'social' behavior (as sharing) led to cooperation that helped the driver and, in turn, those that became passengers or were part of the community. In another sense, too much sharing does not benefit drivers or their communities, but instead that of advertisers, manufacturers, governments and so on. This is a less egalitarian view of sharing and sociability. If information is going to be exchanged between cars, authority, accountability, and the audit trail for when information is viewed and who gets to review it, will also need to be considered. Sharing information and coordinating vehicles enters people and their cars into a different kind of social relationship on the road. Not to mention the new opportunities for criminality as car hijackers/hackers find ways to control vehicles to overtake, steal, or utilize to aid them in their various schemes of either flat out theft or overtaking control of information systems to cause accidents...or worse [12].

3. MULTIPLEXED ATTENTION, AGENCY & SOFTWARE DEVELOPMENT

At present, humans are using mobile devices to extend their capabilities, often doing more than one thing at once. 'Divided Attention,' describes the state of humans focusing their attention on more than one thing at once. Research on divided attention suggests that people are not able to concentrate on other things in their vicinity when walking or driving whilst having a conversation that requires them to process information [13;14]. PoSR extends divided attention to even more extremes as the idea of PoSR multiplexes attention and creates a messaging environment that goes well beyond the physiological systems that enable people do things safely. Thus, the interaction environment described by PoSR poses great challenges to using upcoming technologies to improve the social integration of people and their vehicles, and the entropy of driving conditions combined with PoSR creates a complexity problem that requires a particular kind of Artificial Intelligence (AI) agency to solve. When cars have the potential to be 'social' (even between themselves as machine-to-machine) there exists a high potential for fragmentation due to PoSR related multiplexing. In hardware terms, the ability to parse multiple messages in an automobile is certainly possible. Sensors

could be added to handle needed functionality and a processor could be dedicated to each thing that would give it undivided

attention except for a few input settings. Software is another matter entirely.

Agency is the capacity to make nondeterministic choices from a set of options as events unfold. For example, humans exercise agency in a car when deciding to run a red light, or not, or to turn left and visit friends on the way to the store. The foundation of a social relationship requires the presumption of agency on the part of the other. Otherwise, it is not a social relationship; social relations require that each party assumes the other has agency. Presently cars do not have agency. Anti-lock brakes, airbags and other seemingly automatic features mimic agency in cars, but those are based on decision trees and will not scale to the multiplexed environment of a truly social car.

The capacity for both the human and machine to make genuine choices from a set of options as events unfold is the ideal outcome for a driving environment where events can be unpredictable. In other words, in the case of people within cars, the combination of humans/cars needs to have relatively successful outcomes in order to avoid accidents. The discussion of agency applied to PoSR and the social car comes into the fray not so much because we are concerned with the specific agency of an individual person or car but because to exercise agency in a social context, understanding that others have agency and a context for that agency is essential to an individual applying their own agency. We are suggesting that to be successful, the social car will require an AI that has operational agency in the sense that its own decisions are in part based on the presumption of agency. Bojic et. al. highlight some of the issues and problems relating to integrating machines into social networks [15:89]. However, although they include agency in their argument, they assume this is imposed from outside the social network, whose purpose is to realize this external agency, which is driving the global process as a series of distributed local processes. Manzalini et. al. anticipate the need for distributed agency-driven context awareness [16]. We argue that if there is more than one agency at play, necessarily these local processes must include a presumption of agency on the part of all interacting systems in order to resolve the often conflicting goals of different agencies.

The problem lies in having to manage any loss of information that comes about by distributing the messages across too many different networks. When people do not know enough of the context of the people they are communicating with, they have the potential to make wrong inferences. When communicating in person, people infer things based on many inputs, including observations, which enable them to understand how the other person is situated. When the other person in a communications transaction is situated doing different things that the observer is not aware of, due to being in another car, city, state or country, the initial observer needs to learn to make more conservative estimates of their inferences, or they will be at risk of making wrong judgments. As a rule, more general inferences are less tailored to specific individuals (and situations) and are not necessarily the most accurate or the most efficient. Generalized inferences do not work as well as more tuned coordinated social interchanges. This kind of impact of fragmentation in PoSR could easily happen in an engineering sense: messages, the foundation of sociability, require observations and other data to produce accurate inferences and judgments for successful communication and in turn, successful cooperation.

When observational cues are absent, more conservative general estimates must be made. It is not a hardware problem, the hardware can process whatever it needs to in a vehicle in terms of data, but software is difficult to write because unless there is some type of corrective for contextual interpretation, more conservative judgments will need to be made, which in turn means less efficient/accurate/appropriate judgments, which in turn reduces the scope of what can be accomplished. In a car that is monitoring many different sensor inputs plus potential multiple, multiplexed social messages that contribute to interpretations of PoSR context, plus its own agency, the event of one message interpreted poorly could have disastrous results. This problem also makes it difficult to certify such a system because in order to certify it, nearly all of the local inferences will need to be as close to 100% reliable as possible. Due to variability of interpretations in PoSR with respect to multiplexed messaging from a hypothetically huge number of vehicles on the roads, this becomes nearly impossible.

This complexity problem emerges from a combination of agency, volume of messages and the context of the messages that are both coming in and being sent out to other people and vehicles. Not all messages are available to all segments at all times and an incomplete distribution of the messages creates more confusion, as it is impractical to send everyone every message and expect them to process the data.

Because there only needs to be one message that is not properly contextually transmitted or interpreted for a disastrous result, particularly in an automobile, accounting for a broader range of activities that are happening at any given time will have to be designed into the system. In other words, PoSR contexts might be alleviated somewhat, if the different network members knew something about what other networks each is involved in. Solutions might include agents that summarize different things for different parts of the communications to create more accurate interpretations of messages or to design less efficient systems. What may be a possible solution, in part, is to produce some kind of subsystem that manages context within PoSR. A system of ‘tokens’ could develop for each context and could be transmitted with messages. These could be collected as they flow across more and more networks. Thus, producing a contextual history that is attached to the communications, allowing for the development of more agency on the part of the system.

4.CONCLUSION

A useful means of representing PoSR contexts might include creating some form of dynamic commentary regarding an element’s context that is constructed from any combination of visual, aural or language-based elements that can be modified, rescaled and browsed by end users to find information they require from the present or past about others they are interacting with directly or indirectly in a compact form [7].

Appropriate descriptions of PoSR contexts may offer location aware applications a tractable means of traversing the complexity of single and multiple user experiences while maintaining the complexity required by users (and cars) to construct further applications of the technologies they employ [7].

Highly heterogeneous messaging environments that enable individuals and their cars and/or individuals in cars and their passengers, to connect and communicate with each other and others, can lead to a complex situation that has little overlap for cooperation [8]. This will be especially challenging as the hardware form factor migrates to a head-mounted glasses option. Without restricting the possibilities for PoSR communication, software development that enlists the use of Agents for certain processes and tasks may help to restore ‘order’ in the car. It has been documented that having connection in the car (via the CB

radio research [3], and as evidenced by the overwhelming usage of mobile phones and texting while driving [3;11]) to systems outside the car, is important and valuable for humans. It is worth further exploration to determine if social needs within vehicles remain the same from the CB radio days, or have changed with the times. Furthermore, as the car becomes a fully automated (pardon the pun) form with Artificial Intelligence eventually replacing the human driver, planning for how it will handle the complex multiplexed environment of communications that emerges as PoSR, along with its own newfound agency, within its environment is critical.

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