Ambient Storytelling for Vehicle-Driver Interaction

Jeff Watson[1], Emily Duff[1], Cecilia Fletcher[1], Joshua McVeigh-Schultz[1], Jen Stein[1], and Scott S. Fisher[1]

[1]Mobile and Environmental Media Lab, University of Southern California School of Cinematic Arts, 900 West 34th Street Los Angeles, CA 90089-2211
{jeff.watson, eduff, cecilia.fletcher, scott.fisher, jrmcveig, steinjen}@usc.edu

Abstract. This research initiative explores methods for augmenting and deepening the relationship between a vehicle and its driver(s) over the course of its ownership lifecycle. Using a variety of in-car and cloud-based computing technologies, the USC Mobile and Environmental Media Lab is developing a suite of integrated real-time applications that monitor and analyze the activities of both driver and vehicle in order to safely and seamlessly present and archive customized storytelling, interaction, play, and social experiences across a range of devices and contexts. This paper presents an overview of the project's origins, development, and current status, along with a detailed exposition of a prototype vehicle-driver data aggregation system and touchscreen interface.

Keywords: ambient storytelling, automotive, new lifelog interfaces, pervasive computing, transmedia, vehicle-to-driver interaction, visualization

1 Introduction

This research initiative explores methods for augmenting and deepening the relationship between a vehicle and its driver(s) over the course of its lifecycle. Using a variety of in-car and cloud-based computing technologies, the USC Mobile and Environmental Media Lab is developing a suite of integrated real-time applications that monitor and analyze the activities of both driver and vehicle in order to safely and seamlessly present and archive customized storytelling, interaction, play, and social experiences across a range of devices and contexts. This interdependent "ecosystem" of analytics, interactive systems and visualizations is intended to produce an evolving and ever-deepening relationship between car and driver, making the vehicle, its subsystems, and the spaces it traverses more intelligible, meaningful, and emotionally engaging.

This paper presents an overview of the project's origins, development, and current status, along with a detailed exposition of a prototype vehicle-driver data aggregation system and touchscreen interface for visualization, planning, and review.

1.1 Concept Space: Mobile Experience Design

Pervasive computing technologies enable unprecedented access to timely and information-rich mappings of cities, buildings and other navigable environments. For experience designers, these mappings -- often freely readable and writable through a variety of APIs and interoperable data standards -- can be used in conjunction with network-enabled mobile devices to generate real-time context- and location-aware gameplay, participation, and storytelling experiences. Such experiences combine publicly-accessible geodata with information harvested from everything from purpose-built sensor systems to their users' social media connections and device usage metrics, leveraging the emerging pervasive computing infrastructure to create dynamic, responsive, multidimensional and interactive engagements with physical space, social relations, and material objects.

Much of the present activity in this sector of experience design involves the development of smart phone applications. iPhone games like Dokobots [1], which invites players to collect, share, and tell stories about virtual objects embedded in physical space; Mannahatta [2], which presents participants with a suite of game mechanics and locative interfaces for the social discovery of an archive of historical and ecological information about Manhattan; and Nike+ [3], which allows runners to track and compare their workouts with those of their friends, playfully mix existing social media systems and practices with location sensing and geodata visualization in order to create compelling and engaging new experiences.

For drivers, iPhone applications like Waze [4], which applies Twitter connectivity and a Foursquare-like achievements system to the crowdsourcing of traffic information, point toward the latent potential of smart phones as a means of augmenting and extending driver awareness. But despite this promise, safety concerns related to the active use of handsets while driving remain a significant impediment to the development, deployment, and adoption of such applications. To respond to these concerns, automobile manufacturers have begun the process of integrating social media, game mechanics, crowdsourced recommendation engines, and other elements into their vehicles' onboard navigation systems. BMW's ConnectedDrive [5], Mini's Mini Connected [6], Nissan's Carwings [7], Toyota's Entune [8], and Ford's MyTouch Ford [9], among a handful of others, represent a collective step by the car industry toward a deeper integration of external data sources, game mechanics, and social media practices into vehicular graphical user interfaces.

2 The USC Mobile and Environmental Media Lab

Ubiquitous and embedded computing technologies introduce a new paradigm for how we interact with the spaces of everyday life. Mobile devices, specifically smart phones, offer new possibilities for sensing and communicating with the physical world around us. As these technologies pervade our everyday interactions, the context and location in which they occur becomes more relevant. These technologies can be used not only for collecting and providing data about the world, but also for engaging people in context- and location-specific ambient stories that encompass everyday life.

The USC Mobile and Environmental Media Lab explores context- and location-specific mobile storytelling. Our current research projects focus on interactive architecture and networked mobility within the context of environmental media. Through the use of media technologies, it is our goal to enhance environmental awareness, augment presence in the physical environment, and enable participation in place making [10, 11].

2.1 Car as Character

The USC Mobile and Environmental Media Lab conceives of a personalized contextual interactive system centered on the unique relationships that exist between individual vehicles and their drivers. Such a system addresses traditional onboard vehicular interface use cases of wayfinding, efficiency monitoring, and handset media player connectivity within the context of an adaptive playful and social narrative engagement. By storing and analyzing in real-time both in-car sensor data and extra-vehicular contextual information regarding user milestones, driving patterns, and proximity to other users or relevant geospatial nodes, vehicles equipped with our system can offer their drivers a range of visualizations, procedurally-curated media archives, and playful experiences tailor-made to their unique usage and engagement profiles. Furthermore, and perhaps most importantly, our system is designed to analyze not only the ways that drivers engage with space, media, and other drivers, but also the ways in which drivers choose (or refuse) to engage with the system itself. This iterative feedback loop between vehicle and driver creates an increasingly customized and granular palette of interactions and behaviors that constitute a unique, emergent, and constantly-evolving "character" for the vehicle. Finally, by storing user profile and vehicle character parameters in the cloud, the system can be accessed via a variety of onboard and extra-vehicular interfaces, including touchscreen devices, laptops, and smart phones, extending the vehicle-driver relationship beyond the confines of the cockpit.

3 Touchscreen Interface Prototype

To demonstrate this system, the USC Mobile and Environmental Media Lab has created an interactive touchscreen application prototype for the Microsoft Surface using 1,512 lines of Processing code. These technologies were selected for their ease of use in the generation of a functional prototype; future iterations of the system will be deployed on iOS and Android devices, among others.

The demonstration interface has two primary operational modes: the **Lifelog**, which presents the user with an interactive timeline of their relationship with their vehicle on a variety of temporal scales; and the **Map**, which provides a geospatial view of ongoing relationship data, along with tools for trip planning, game play, and social media integration.

Fig. 1. Touchscreen interface in Lifelog Mode (left) and Map Mode (right).

Interacting with the table begins when the user places a machine-readable fiduciary marker object (or "roundel") onto the surface. This object functions as a hyperlink to the user's profile, enabling the table to request and display a specific dataset from the database. This object also functions as the key with which the user can unlock and start their vehicle, providing a tangible link between visualization and the actual driving experience. To create the marker object for this demonstration, we exported a 3D model created in Maya to a Z Core CNC printer to create a circular plastic "roundel" displaying the BMW logo, with the fiduciary marker printed on the obverse. Placing the roundel onto the surface activates the interface. By moving the roundel to different quadrants of the screen, the user can switch between modes and activate other functionality.

3.1 Lifelog Visualization: Overview

The Lifelog is the default screen activated by the placement of the roundel on the surface. Upon recognizing the roundel's fiduciary marker, the system displays a circular timeline of information, using the roundel itself as the center of the circle. This visualization metaphor is akin to the rings of a tree, with the oldest ring of data closest to the center. Each ring is then divided into color-coded slices which represent different categories of vehicle-driver interaction, with the relative length of each slice mapped to the volume of data it contains. By moving their fingers across these slices, users can scroll through detailed information about the history of their relationship with their vehicle, accessing a variety of media objects and data sources. By toggling a menu in the upper right corner of the screen, users can switch between time scales, viewing their Lifelog by year, month, or week. Finally, by dragging media objects onto social media icons in the upper left corner of the screen, users can easily share these objects with friends and the world at large.

Each slice of each ring in the timeline yields additional media interfaces, exposing the images, video, audio, driver achievements, connections to other drivers, and other information that the system has collected since the very beginning of the vehicle-driver relationship.

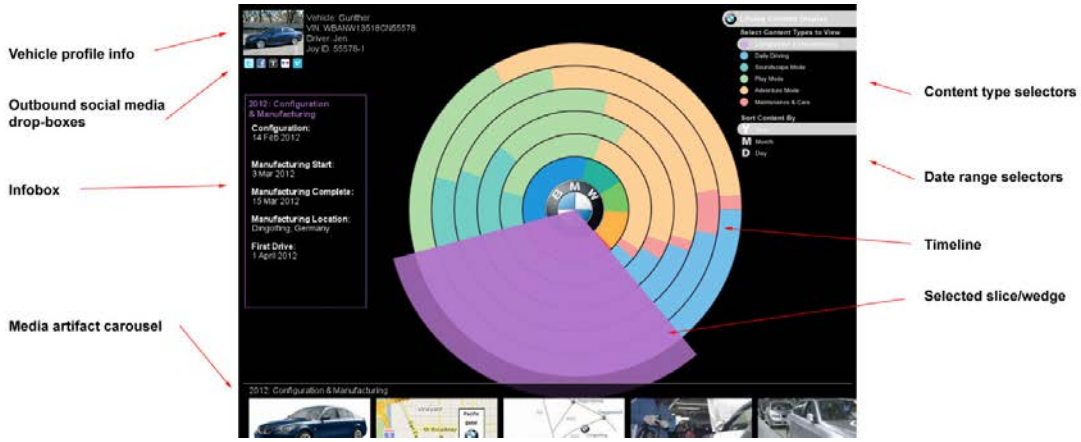

Fig. 2. Touchscreen interface in Lifelog mode, displaying media artifacts and information related to a touch-selected slice or wedge in the timeline.

3.2 Activity Types

We chose to represent six distinct types of vehicle-driver interactions and activities in the Lifelog visualization. This collection of interactive activity archives reflects our larger vision of how playfulness, sociability, and storytelling can be integrated into the experience of owning and driving a vehicle. Each kind of activity represented in the Lifelog visualization belongs to one of two broad sets, namely: Usage Monitoring and Joy Modes.

3.3 Usage Monitoring

Usage Monitoring visualizations expose everyday use patterns, onboard subsystem activity, and the material history of the vehicle.

Configuration and Manufacturing: For our demo use case, the relationship between car and driver begins with the initial configuration of the vehicle via an online ordering system accessed either at home or at a dealership. As such, this phase of the relationship constitutes the primary slice of the inmost ring of the timeline. When touched by the user, this slice opens an at-a-glance info box on the left side of the screen, which displays basic information such as the date of initial configuration and manufacture; and a sliding media interface along the bottom part of the screen that displays images, maps, documents, and other artifacts related to the vehicle's initial configuration and manufacture. Through this interface, the user can delve more deeply into the origins of their vehicle and its carbon footprint by viewing photos and video from its passage through the factory or by engaging with an interactive map displaying real-time information about the movement of the vehicle's constituent parts from manufacturers around the world. For new owners, this interface can constitute a powerful first encounter with their car, as they watch it being made and delivered in real time.

Daily Driving: Touching this slice displays media artifacts and information related to mileage, travel range, onboard systems usage, and proximity contacts with a variety of static and dynamic geospatial nodes (landmarks, friends, etc). As with each component of the timeline interface, these items appear in a sliding media interface along the bottom of the screen, and each item is sharable via the social media icons at the top left. An at-a-glance info box on

the left side of the screen displays aggregate driving statistics and lists any special achievements the driver may have unlocked during the specified time period.

Maintenance and Care: Information regarding accidents, systems failures, routine maintenance visits, and repairs is accessible by touching this slice of the timeline. Important media artifacts such as photographs of accident scenes, repair reports, and insurance documentation are aggregated here, and can easily be shared with relevant parties via social media and email. An at-a-glance info box provides additional information about upcoming scheduled maintenance appointments and the status of onboard systems.

3.4 Joy Modes

The second set of interactions and activities depicted in the Lifelog visualization relates to a cluster of playful, cinematic, geolocative and social augmentations to the driving experience and vehicle-driver relationship. These augmentations (or "**Joy Modes**") are crucial elements of the system's overall network of interactions and feedback loops, and both express and shape the evolving character of the vehicle:

Soundscape: Using a multitude of onboard and extra-vehicular data sources, Soundscape dynamically generates a real-time soundtrack that cinematically augments the experience of driving. Like contemporary music visualizers such as that found in media players such as Apple's iTunes, Soundscape uses a flow of data to procedurally generate an aesthetic experience. Just as iTunes uses a music file as the numerical seed for the generation of visuals, Soundscape uses geodata and onboard sensor data (including measurements of engine activity, exterior light conditions, velocity, proximity to other vehicles, and more) to produce a constantly-changing ambient audio experience. Drivers can listen to Soundscape in real time as they drive, or can listen to it later via extra-vehicular interfaces. Whether users choose to listen or not, Soundscape is always working in the background and its output is archived as an aggregate sonic representation of driving activity. By touching the Soundscape slices on the touchscreen timeline, users can activate an interface to play, edit, and share via social media all the Soundscapes that have been generated over the course of their vehicle's ownership lifecycle.

Play Mode: Play Mode dynamically generates game activities by drawing on the aggregate data collected by the Lifelog regarding the preferences, driving habits, geospatial range, and social connections of a given driver. These activities are then presented to the driver via the vehicle's onboard interfaces in contexts and situations that the system has determined are appropriate for play. For example, suppose you have driven your child to soccer practice just as a rainstorm has broken out. By analyzing previous usage patterns and current weather conditions, your car determines that you now find yourself on the road, with your child, and with a few spare minutes. At this moment, the vehicle might intervene and offer you the opportunity to play a game. Such games would use the local environment as the game board for a "big urban game," wherein tackling challenges by driving to certain locations or safely interacting with other drivers scores points, unlocks badges, and generates memorable media artifacts. In the Lifelog visualization, players can scroll through their achievements and any photos or videos generated in the course of a game by touching relevant slices of the timeline. Touching these slices also activates an at-a-glance info box that enables connection to the broader community of players, displaying leaderboards and recent achievements by friends in the driver's social networks.

Adventure Mode: Like Play Mode, Adventure Mode uses Lifelog data to dynamically generate highly customized context-sensitive geospatial "adventures" that drivers can engage with as either focused one-off events or as ambient "always on" experiences. For example, a driver whose profile suggests an interest in architecture could be presented with a custom-made guided tour of notable architectural sites within the range of their daily driving patterns. By handing the reins of navigation over to their vehicle, drivers who want to engage with an adventure can find themselves being directed to interest-specific sites in their area that they have never been to before, discovering new

corners of their lived environment. While on these adventures, the vehicle itself collects photos and unlocks achievement badges that the driver can later view and explore further -- perhaps by linking out to relevant websites or other online resources -- via relevant timeline slices on the touchscreen interface. Further, drivers can recommend particularly interesting adventures to other drivers via the Lifelog visualization's social media interface, and can even design adventures of their own to send to friends and family.

3.5 Map Interface: Overview

In contrast to the Lifelog interface, which provides users with ways to access the history of their relationship with their vehicle, the Map interface provides a set of tools for engaging with the present and future of that relationship.

The Map interface is activated by moving the roundel to the bottom-left corner of the surface. This move triggers a transition that replaces the timeline, infobox, and media carousel of the Lifelog with a scrollable circular interactive map and a tabbed infobox containing trip planning tools and two kinds of real time newsfeeds. This interface provides access to datasets related to the user's current position in space and time. Relevant information regarding Usage Monitoring and Joy Modes is also displayed via this interface.

Fig. 3. Touchscreen interface in Map mode, displaying a modal (pop-up) window in the map area, and a geosocial news feed in the tabbed infobox.

3.6 Trip Planning and Review

The Map interface affords users the ability to set destinations and waypoints relative to either their current position or to an arbitrary starting point. Route optimization, traffic analysis, accident alerts, and other standard mapping features enable users to quickly generate maps and turn-by-turn driving directions that will automatically sync with their vehicles' onboard mapping GUIs (see 3.8).

In addition to these traditional use cases, the Map interface also displays location- and context-sensitive information related to usage monitoring, Joy Modes, and proximal social media connections. Driving milestones, custom Joy Mode engagement opportunities, and nearby friends appear on the map as touch-activated icons. By touching a particular icon, users can view a modal window containing relevant information. The system will then ask the user if they would like to plot a route to that location or amend an existing route in order to take a social or Joy Mode-related detour. In addition to a graphical depiction of any routes the driver generates, the system will also provide a text list of directions - along with some data about estimated times and any social or Joy Mode activities the user has incorporated into their route - in the tabbed infobox on the left side of the screen.

Finally, users may also access and view previous trips by scrolling through a route archive that appears in the "Trip Details" tab of the Map interface infobox. By selecting a trip from the past, users can view the GPS trails

they have generated in the course of daily driving, along with a layer of icons displaying any milestones or achievements they may have unlocked in the course of their travels. For example, a user who has returned from a Sunday drive during which they chose to undertake a Adventure or engage in a Play Mode activity (see 3.4) will see a special layer of icons on the map depicting key stops related to these activities. Clicking on these icons will display information about the user's own engagement with a given activity, along with other information, including links to friends who have undertaken the same Adventure or played the same game, leaderboards, and visualizations of various performance statistics. Users may also use this functionality to explore the Soundscapes that have been automatically generated by their vehicle during everyday driving by dragging their finger along an archived route.

3.7 News Feeds and Proximal Notifications

The tabbed infobox on the left side of the Map interface also allows users to view location- and context-sensitive lists of proximal social media connections - including everything from Yelp! reviews to the location of friends and affinity groups who have chosen to share geodata through services such as Facebook Places, Foursquare, Google Latitude, or Twitter - and Joy Mode activities. These lists will update and filter depending on the route(s) the user plans out using the Map and trip planning tools. If no route is currently planned, the lists will filter based on the current location of the user's vehicle. Any Joy Mode activities presented to the user are selected based on their own driving habits and history of interactions with their vehicle, and as such function both as an expression of the car's evolving character and as a means of generating new data for further refinement of both driver profile and vehicle Lifelog.

3.8 Physical Connections Between Contexts: Transitioning From Extra-Vehicular Interface to Onboard GUI

Once the user is ready to head out onto the road, they can sync their touchscreen interface with their vehicle's onboard interactive systems by moving the roundel to the bottom right corner of the screen. Doing so causes a visual transition wherein the graphical elements on the screen appear to collapse into the roundel itself. When the driver enters their vehicle - unlocking and starting it with the roundel - they will see a similar visualization of data transfer on their vehicle's dashboard GUI. Although the data is in fact being synced between devices via a cloud server, this illusion of a vessel containing the digital essence of the user's vehicle provides a tangible connection between driver and vehicle. In this sense, the roundel becomes a kind of totem representative of the vehicle's character. Because the roundel also functions as the key to the vehicle, this totemic function effectively applies a layer of story and relationship atop the user's natural practice of carrying around and taking care of their keys.

4 Future Directions

The USC Mobile and Environmental Media Lab intends to expand our prototyping to include more real time data sources (both onboard and environmental), multiplatform interface integration (Android, iOS), and additional cockpit interaction systems (touchscreen, gestural). Because driver engagement is so crucial in the generation of granular and customized vehicular character traits, we will also focus on developing compelling proof-of-concept game mechanics (Play Modes) and geospatial archive interfaces (Adventure Modes). By increasing both the density and range of incoming sensor data, and by expanding the number and variety of engagement opportunities, we hope to uncover new ambient storytelling and participation paradigms that will leverage pervasive computing to create rich narrative engagements between drivers, passengers, and the vehicles they use.

5 Acknowlegements

The USC Mobile and Environmental Media Lab would like to thank Stephan Hoch and Stephan Durach of the BMW Technology Office (Palo Alto, CA), and Lee Dirks and John Nordlinger of Microsoft Research. This project would not have been possible without their support.

References

1. Dokobots, http://dokobots.com/
2. Mannahatta: The Game, http://wakatta.parsons.edu/mtg/mtg.html
3. Nike Running: What is Nike+?, http://nikerunning.nike.com/nikeos/p/nikeplus/en_US/what_is_nike_plus
4. Waze, http://www.waze.com/
5. BMW ConnectedDrive: Introduction, http://www.bmw.com/com/en/insights/technology/connecteddrive/overview.html
6. Mini Connected, http://itunes.apple.com/us/app/mini-connected/id376699654?mt=8
7. Nissan Carwings, http://www.nissan-global.com/EN/ENVIRONMENT/SOCIAL/CARWINGS/
8. Toyota Entune, http://www.toyota.com/entune/
9. MyFord Touch, http://www.ford.com/technology/sync/myfordtouch/
10. Stein, J. and Fisher, S.: Ambient Storytelling: The Million Story Building. In: ACM SIGCHI Conference on Tangible, Embedded, and Embodied Interaction. Funchal, Portugal (2011)
11. Stein, J., Otto, G., and Fisher, S.: Interactive Architecture: Connecting and Animating the Built Environment with the Internet of Things. Internet of Things Conference. Tokyo, Japan (2010)

Appendix: Video Documentation

Video documentation for the touchscreen interface prototype is available online at http://mobilemedia.usc.edu/?p=47