The Driving Machine: Mobile UX Design That Combines Information Design with Persuasion Design

Aaron Marcus and Scott Abromowitz

Aaron Marcus and Associates, Inc.,
1196 Euclid Avenue, Suite 1F, Berkeley, CA, 94708 USA
Aaron.Marcus@AMandA.com, scott@abromo.com

Abstract. Travel and tourism is a booming sector of the 21st century world economy. Vehicles are becoming smarter and using advanced graphical displays. The Driving Machine seeks to provide an innovative vehicle dashboard that combines information design and persuasion design to change the driver's behavior, promoting safety and fuel efficiency, or sustainability.

Keywords: dashboard, design, development, experience, incentives, information, interface, mobile, persuasion, safety, social networks, sustainability, user, vehicle.

1 Introduction

A 21st-century global vehicle dashboard-design challenge is to take advantage of technology to increase safety and conserve energy. The context is this: advances in technology increase driving distractions, and global warming increases our desire to reduce our carbon footprint. In particular, the Green movement has helped to increase people's awareness of sustainability issues and propelled development of innovative products to help decrease our ecological footprint.

The Driving Machine seeks to increase safe driving-behavior and fuel-efficient driving by offering information, overviews, social networking, just-in-time knowledge, and incentives, including gamification, that can help to reduce, even prevent, vehicular accidents and promote more fuel-efficient driving. The question then shifts to how best to motivate, persuade, educate, and lead people to adopt safe-driving behavior and reduce their energy consumption. For our project we researched and analyzed powerful ways to improve safe and green behavior by persuading and motivating people to become more alert drivers and to reduce their energy consumption through a vehicle dashboard application we call the "Driving Machine."

Dashboards and automotive-related applications are available to increase people's awareness of safety and the environment, but such technologies often do not focus on innovative data visualization, and they may lack persuasive effectiveness to encourage drivers to continue good driving behavior. Communicating one's carbon footprint, driving skills, and alertness, helps build awareness and identity, but does not result automatically in effecting behavioral changes. The question then becomes: How can we better motivate, persuade, educate, and lead people to become safer and

A. Marcus (Ed.): DUXU/HCII 2013, Part III, LNCS 8014, pp. 140–149, 2013.

more efficient drivers? Aaron Marcus and Associates, Inc. (AM+A) has embarked on the conceptual design of a mobile-phone/tablet-based product, the Driving Machine, intended to address this situation.

The author's firm previously designed and tested similar concept prototypes that seek to change people's behavior: the Green Machine application in 2009, oriented to persuading home consumers to make energy-conservation behavior-changes; the Health Machine application in 2010, oriented to avoiding obesity and diabetes through behavior changes regarding nutrition and exercise; and the Money Machine in 2011, targeted to baby boomers and oriented to assisting them to manage their wealth more effectively. The Driving Machine uses similar principles of combining information design/visualization with persuasion design. The Driving Machine's objective is to combine information design and visualization with persuasion design to help users achieve their goals of driving more safely and efficiently by persuading users to adapt their driving behavior, for example to follow traffic laws better and adopt carpooling behavior. AM+A intends to apply user-centered design along with persuasive techniques to make the Driving Machine highly usable and to increase the likelihood of success in adopting new driving behavior. This white paper and an accompanying presentation explain the development of the Driving Machine's user interface, information design, information visualization, and persuasion design.

2 Initial Discussion

As the amount of computing technology continues to increase in our cars and trucks, careful consideration must be given to dashboard design to ensure the safety and reliability of drivers, passengers, and vehicles. Increasingly states are passing laws that limit drivers' abilities to operate mobile phones or to read/send text messages while driving. Recent research illustrates that even such laws may not go far enough, as cited by Paul Green (see Bibliography). Paul Green describes how driving and using a cell phone, regardless of having hands free or not, places drivers at greater risk of causing accidents than drivers who only talk to passengers inside their vehicles. The reason talking on the phone is a greater danger than talking to passengers is because passengers are more aware of current driving situations than people being communicated with on the phone. One study by Redelmeier and Tibshirani cite, as stated by Green, that using a cell phone increases the likelihood of a crash by up to 4.3 times versus those not using a cell phone while driving. Estimates for distraction-related crashes in the United States typically come from a sample of about 5,000 police-reported crashes called the Crashworthiness Data System (CDS) [Green, 2003]. To overcome future problems that new technologies might have on driving, the National Highway Traffic Administration (NHTASA) proposed a set of guidelines to test the impact of a specific task on driving performance and safety. If a task is deemed too distracting to a driver's focus based on the Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices, NHTASA encourages automobile manufactures to prevent a driver's from being able to perform the interfering task [National Highway Traffic Safety Administration, 2012].

AM+A previously has done research for BMW (2002) in a report titled "Future HMI Directions," in which AM+A thoroughly researched a driver-centered approach to HMI (Human-Machine Interaction). Although the report is over ten years old, the human factor issues are still highly relevant today as evidenced in Green's research and the NHTASA report. In addition to safety, designing a system that encourages being environmentally conscious is an important attribute of our research. While fuel prices and the threat of global warming continue to rise, carpooling in the United States is at a very low 11% [Johnson, Jones, & Silverman, 2010]. Services such as Zimride seek to counter the low rate of carpooling by creating a social network where people can be drivers and passengers in carpools. Zimride also offers Lyft, which helps those who would normally travel alone in a taxi request on-demand ridesharing. Honda Motors developed its Ecological Drive Assist System to encourage efficient driving by supporting behavior change, in offering visual feedback via an ambient green or blue color, and also by gamifying driving behavior through the design of virtual leaves for more sustainable driving [Honda Motors, 2008].

Our research shows that an innovative approach to vehicle dashboard design must account for the following: design for safety where a driver easily should be able to take a second glance at a display cluster and then refocus his/her attention on the road. Next, a display cluster must not increase the level of complexity that a driver encounters. For example, a focus on helpful rather than powerful features is important to ensure a reduction of complexity. A graphical user interface should not focus on visual complexity with an overabundance of graphics; rather, it must use graphics only if it enhances dynamic content that would otherwise be less visible. The user interface should not constrain the user to conform to a particular layout, but instead allow him/her to customize the available information present in the digital dashboard. Lastly, the dashboard development must follow a user-centered design process. The user-centered user-experience design (UCUXD) approach links the process of developing software, hardware, and user-interface (UI) to the people who will use a product/service. UCUXD processes focus on users throughout the development of a product or service. The UCUXD process comprises these tasks, which sometimes occur iteratively: planning, research, analysis, design, implementation, evaluation, and documentation. AM+A carried out these tasks in the development of the Driving Machine concept design, except for implementing working versions.

3 Personas and Use Scenarios

To better understand the demographics and to focus on creation of user-centered designs, our company incorporates the use of personas (user profiles). Personas are characterizations of primary user types and are intended to capture essentials of their demographics, contexts of use, behaviors, and motivations/objectives, and their impact on design solutions.. For the Driving Machine personas, we identified three target markets: young drivers, early adopters, and elderly drivers and defined appropriate personas, male and female, aged 17-73, from several racial/ethnic groups

(see full description in the AM+A White paper [Marcus, 2013]). We wrote their descriptions, vehicle-related objectives, contexts, behaviors, and design implications. We wrote use scenarios for each person and a general use persona. Use scenarios are a UI development technique that emphasizes user-centered stories about product/service use. The following general use scenario topics were drawn from three personas because we anticipated that these would be representative of the others.

Carbon Footprint Monitoring

- Receive up-to-date articles, advice, and tips regarding monitoring current and past driving behavior.
- Set customizable alerts for driving, whether positive or negative
- Receive unsafe alerts
- Establish and maintain objectives (*e.g.,* "I want to reduce my carbon footprint")
- Establish and maintain goals (*e.g.,* specify number of people you want to drive in a carpool). See the ramifications of this goal on current and past trends.
- Visualize and monitor the carbon footprint

Carpooling

- Share current location with people near by
- Alert driver of any potential passengers
- Visualize and monitor the number of and location of carpool passengers

Social Media

- Post green/efficient driving achievements on the users' own walls and possibly their friends' walls, similar to a merit-badge system
- Connect with insurance agent by automatically sending them status reports on your driving behavior
- Share tips and strategies with specific friends or family
- Import personal information from social media sites (*e.g.,* race, sex, age). Users not connected to a social media site can add their information manually through the Driving Machine
- Resolve any urgent ethical issues

Gamification

- Set and use pre-existing achievements to help reduce insurance premiums
- Compare estimated fuel economy to actual fuel economy
- Earn badges for being a driver in a carpool or on-demand carpool
- Purchase carbon offsets by carpooling
- Reward posting gas prices with gas reward cards
- Develop an "economy of tipsterism," likes and dislikes, bribes and no bribes, objective *vs.* biased opinion, *etc*.

4 Competitive Analysis

Before undertaking conceptual and perceptual (visual) screen designs of the Driving Machine, AM+A first studied six dashboard user interfaces. Through screen comparison-analysis and analysis of recent articles about trends in vehicle dashboard design, AM+A derived a synopsis of each dashboard's features, which contributed to improvements of initial ideas for the Driving Machine's detailed functions, data, information architecture (metaphors, mental model, and navigation) and look-and-feel (appearance and interaction). We considered the following products:

- **Audi A8 dashboard:** Audi's A8 dashboard incorporates a traditional instrument cluster with a large LCD between gauges. The system uses the Internet to grab fuel prices and find points of interest via Audi connect.
- **Cadillac User Experience:** The Cadillac User Experience (CUE) incorporates an LCD display in lieu of a traditional analog instrument cluster to allow for greater user customization. The CUE unifies Cadillac's infotainment and telematics systems for a more uniform user experience.
- **Ford SmartGauge with EcoGuide:** The EcoGuide is a system that coaches a driver how to maximize his/her fuel economy by incentivizing driving behavior. A key component of coaching behavior change is Efficiency Leaves, which grows leaves by driving efficiently or shrinks leaves by driving less efficiently.
- **Honda Ecological Drive Assist System:** Honda's Ecological Drive Assist System incorporates three functions for greater fuel economy: an ambient color meter, a continuously variable transmission, and a scoring function. Together these three components seek to use persuasive techniques to encourage drivers to drive more environmentally friendly. The System's scoring function is visible via the ability to grow leaves depending on a driver's driving efficiency.
- **Johnson Controls Multilayer Instrument Cluster:** Johnson Controls' prototype dashboard user-interface seeks to utilize spatial techniques to allow for prioritizing driving data such as speed and assistance information depending on the driving conditions.
- **1.6 Nissan Leaf Dashboard:** The Nissan Leaf Dashboard is a two-tier dash that separates driving diagnostics such as current speed and battery range. Nissan's system seeks to influence driving behavior by using persuasive techniques through which a driver is able to grow leaves depending on how efficient he or she drives.

From our investigations of dashboard and automotive-related applications, including those cited above, AM+A concluded that usable, useful, and appealing vehicle user-interface (UI) design must include incentives to lead to behavior change. Safe and sustainable driving behavior is possible by providing incentives such as a games, and just-in-time systematic instructions to motivate people to change their behavior. The proposed Driving Machine needs to combine persuasion theory, provide better incentives, and motivate users' to achieve short-term and long-term behavior change

towards a Driving Machine everyday user. Our Driving Machine concept assumes that the primary vehicle dashboard is one of approximately six screens that might be available in a vehicle, three in the front and three in the rear behind the front seats.

The Driving Machine should be non-obtrusive, but encouraging to use. Well-designed games will serve as an additional appealing incentive to teach, *i.e.*, to train the driver. Drivers should be able to receive badges for accomplishing certain tasks. The Driving Machine should allow users to share their experience with friends, family members and the world, primarily through Facebook and Twitter. The Driving Machine should also allow drivers to communicate their experiences with insurance companies to allow drivers to receive reduced rates, and with family/friends.

Based on these concepts and available research documents, we have proposed and are developing conceptual designs of the multiple functions of the Driving Machine. Subsequent evaluation will provide feedback by which we can improve the metaphors, mental model, navigation, interaction, and appearance of all functions and data in the Driving Machine's user interface. The resultant improved user experience will move the Driving Machine closer to a commercially viable product/service. In particular, we believe a well-designed Driving Machine will be more usable, useful, and appealing to memory-conscious users, especially those experiencing long and short-term memory loss. Another objective is to provide a dashboard experience that can reliably persuade people to become safer and energy-conscious drivers.

5 Persuasion Theory

According to Fogg's persuasion theory [Fogg, B. J., and Eckles,D., 2007] to create behavioral change through the Driving Machine, we have defined four key processes, each of which affects the application:

- Increase frequency of reporting driving behavior to social networks
- Motivate changing some driving habits: talking on the phone, texting while driving, follow traffic laws, and driving over the speed limit
- Teach how to drive efficiently (*e.g.*, green, use less fuel)
- Persuade drivers to carpool

We drew on Maslow's A Theory of Human Motivation [Maslow, 1943], which he based on his analysis of fundamental human needs. We adapted these to the Driving Machine context:

- The safety and security need is met by the possibility to visualize the amount of food expense saved
- The belonging and love need is expressed through friends, family, and social sharings and support

- The esteem need can be satisfied by social comparisons that display weight control and exercise improvements, as well as by self-challenges that display goal accomplishment processes.
- The self-actualization need is fulfilled by being able to visualize the improvement progress of the health mattered indexes and mood, and also by predicting the change of the users' future health scenarios.

6 Information Architecture

AM+A believes that effective Machine design that combines information and persuasion requires these essential components:

- Dashboards: How am I doing now?
- Overview: What is my path, structure/process?
- Focus on social networks
- Focus on just-in-time knowledge: Tips and advice
- Incentives: Games, awards, rewards, competitions, stores

Based on the above, AM+A designed the information architecture shown in Fig. 1.

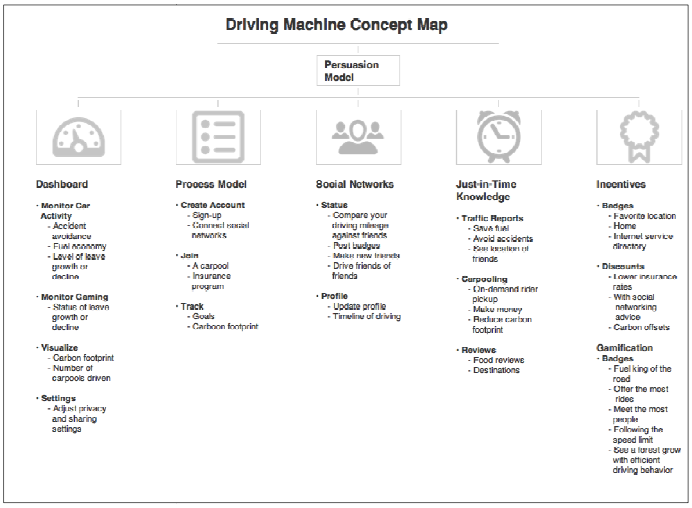

Fig. 1. Diagram of the Driving Machine information architecture

7 Screen Designs

AM+A designed key tablet screens shown in Figures 2-11.

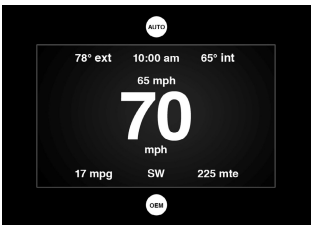

Fig. 2. Dashboard **shows all default information.** An automobile logo and original equipment manufacturer (OEM) logo are at top/bottom. The inner rectangle shows (clockwise from top left) external temperature (78 °ext), time (10:00 am), internal temperature (65 °int), miles to empty (225 mte), compass (SW), and miles per gallon (17 mpg). In the center, the current speed appears as large numbers (70 mph) with the speed limit in smaller numbers above (65 mph).

Fig. 3. Figure 3: Dashboard shows all industry-standard indicators that could appear (e.g., low gas, emergency brake engaged, maintenance required)

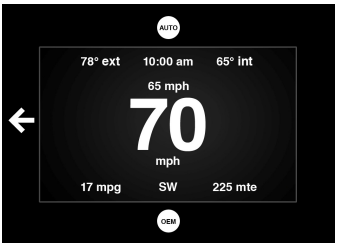

Fig. 4. Dashboard with the left-turn signal

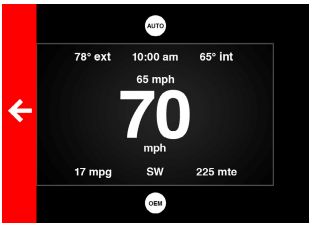

Fig. 5. Dashboard **with left-turn collision signal**. The red bar indicates the car is close to colliding with an obstacle on the left.

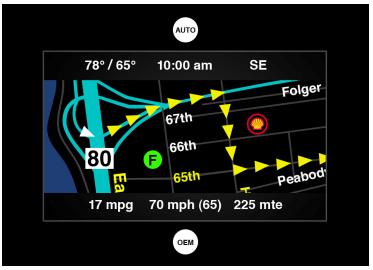

Fig. 6. An **alternative dashboard view, which emphasize navigation capabilities.** The dashboard showcases the same elements (clockwise from top left), external temperature/internal temperature (78°/65°), time (10:00 am), compass (SE), miles to empty (225 mte), current speed (speed limit) (70 mph (65)), miles per gallon (17 mpg).

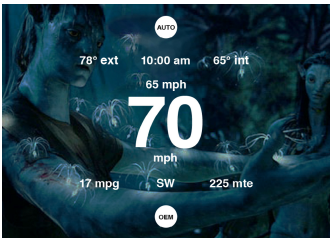

Fig. 7. A **dashboard view with a themed background featuring the movie, "Avatar"** Users would be able to shift and select different themed backgrounds or "skins" depending on interest, pre-designed to ensure maximum legibility/readability. (Image Credit: Fair use of copyrighted material.)

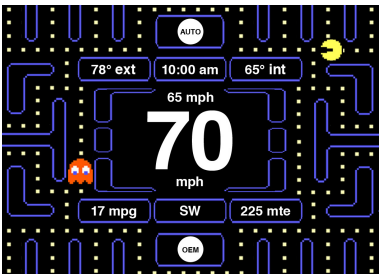

Fig. 8. A **dashboard view with a themed background featuring the game, "Pacman."** (Image Credit: AM+A design using Pac-Man-like image elements. Fair use of copyrighted materials.)

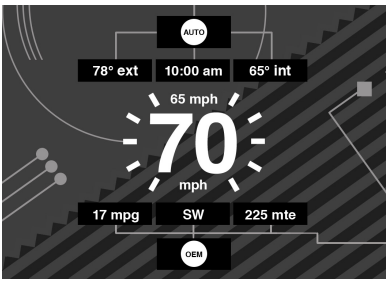

Fig. 9. A dashboard view with a themed background inspired by Swiss typographer, Wolfgang Weingart. The "sparkles" would turn red when the driver exceeds the posted speed limit.

Fig. 10. A **dashboard with a themed background that indicates the eco-friendliness of a driver's behavior**. The more eco-friendly the driving, the more trees will appear. (Image Credit: Tree image by Megan Chiou. Used with permission.)

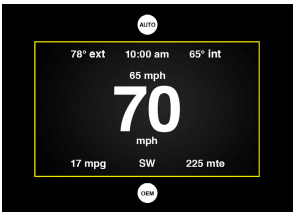

Fig. 11. The **dashboard indicates a driver's eco-friendliness.** Red, yellow, or green outlines indicates the driver is/isn't making efforts to drive in ecofriendly.

8 Next Steps and Conclusions

Following the user-centered development process described above, AM+A plans to continue to improve the Driving Machine screen designs. AM+A aimed to incorporate information design and persuasion theory for behavior change into a mobile tablet application that would constitute an advanced vehicle dashboard. The approach has already been demonstrated successfully with a previous project, the Green Machine [Marcus and Jean, 2010], versions of which have been considered and used by SAP for enterprise software development [Marcus, Dumpert, and Wigham, 2011].

AM+A's long-term objective for the Driving Machine is to create a functional working prototype to test whether the application can actually persuade people who experience driving challenges to exercise greater vehicle control, increase safety, and reduce their carbon footprint.

Acknowledgements. The authors thank Ms. Megan Chiou, AM+A Designer/Analyst, for her significant assistance to design images for this paper.

References

1. Audi A8. Audi of America (2012), http://models.audiusa.com/a8 (retrieved August 10, 2012)
2. Berman, B.: EV Expert Says Nissan LEAF's Dashboard Lacks Most Important Number. PluginCars.com. (December 21, 2010), http://www.plugincars.com/ev-expert-says-nissan-leaf-dashboard-lacks-most-important-number-106590.html (retrieved August 10, 2012)
3. Cialdini, R.: The Science of Persuasion. Sci. American 284, 76–81 (2001)
4. Fogg, B.J., Eckles, D.: Mobile persuasion: 20 perspectives on the future of behavior change. Persuasive Technology Lab, Stanford University, Palo Alto, CA (2007)
5. Ford's Smartgauge With Ecoguide Coaches Drivers to Maximize Fuel Efficiency on New Fusion Hybrid | Ford Motor Company Newsroom (October 28, 2008), http://media.ford.com/article_display.cfm?article_id=29300 (retrieved August 10, 2012)
6. Green, P.: The human-computer interaction handbook. In: Jacko, J.A., Sears, A. (eds.), pp. 844–860. L. Erlbaum Associates Inc., Hillsdale (2003), http://dl.acm.org/citation.cfm?id=772072.772126 (retrieved)
7. Honda Motors. Honda Develops Ecological Drive Assist System for Enhanced Real World Fuel Economy: Implementation on All-New Insight Dedicated Hybrid in Spring 2009 (Press Release) (2008), http://world.honda.com/news/2008/4081120Ecological-Drive-Assist-System/ (retrieved)
8. Johnson, T., Jones, S., Silverman, A.: Programs hope to reverse skid in car pooling - USATODAY.com. (August 5, 2010), http://www.usatoday.com/news/nation/2010-08-04-carpooling-down_N.html (retrieved August 9, 2012)
9. Marcus, A., Chen, E., Brown, K., Ball, L.: BMW: Future HMI Directions. Aaron Marcus and Associates, Inc. (2002)
10. Marcus, A., Dumpert, J., Wigham, L.: User-Experience for Personal Sustainability Software: Determining Design Philosophy and Principles. In: Marcus, A. (ed.) HCII 2011 and DUXU 2011, Part I. LNCS, vol. 6769, pp. 172–177. Springer, Heidelberg (2011), http://www.springerlink.com/content/f81m37795r3743v7/abstract/
11. Marcus, A., Jean, J.: Going Green at Home: The Green Machine. Info. Design Jour. 17(3), 233–343 (2010)
12. Maslow, A.H.: A theory of human motivation. Psychological Review 50, 370–396 (1943)
13. Multilayer Instrument Cluster, Johnson Controls Inc. (n.d.) (August 10, 2012), http://www.johnsoncontrols.com/content/us/en/about/our_company/featured_stories/multilayer_instrument.html
14. National Highway Traffic Safety Administration. Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices (2012)
15. Ziegler, C.: Cadillac CUE: driving is safer (and more dangerous) than ever. TheVerge (August 8, 2012), http://www.theverge.com/2012/8/6/3220366/cadillac-cue-safety