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**ABSTRACT**

To explore the role of social interactions in individuals' assessments of plug-in hybrid electric vehicles (PHEVs), this study analyzes over 190 social (interpersonal) interactions elicited in interviews with 31 individuals in eight different social networks centered on households in the Sacramento, California region. Results are framed within five theoretical perspectives on social influence: contagion, conformity, dissemination, translation, and reflexivity. Responses within networks centered on participants in a study of consumer response to plug-in hybrid electric vehicles (PHEVs) suggest that interpersonal interactions do shape consumers' assessments of PHEVs, and likely electric-drive vehicles generally. Characterizing how social interactions influence vehicle assessments and adoption behaviors, contagion (including diffusion of innovations), conformity, and dissemination provide useful concepts, but translation and reflexivity better provide the language and theoretical depth required to integrate the various motives and perceptions observed. Through translation and reflexivity, preliminary analysis suggests that certain types of households and social network may be more amenable to developing new, pro-societal interpretations of vehicle technology—particularly those households that: i) are in a liminal state in their lifestyle practices, ii) already have a basic understanding of functional aspects of PHEV technology, and iii) find supportive pro-societal values within their social network. This exploratory, qualitative study demonstrates that social interactions are important and their study benefits from the development and use of behaviorally realistic theoretical frameworks to advance transportation and energy policies that rely on the widespread uptake of new technologies.

## 1. INTRODUCTION

This paper explores the role of social interactions within the questions of how and why consumers buy new products, specifically, electric-drive vehicles. Currently, the dominant approach follows the diffusion of innovations (DOI) model, where product adoption is assumed to be driven by the diffusion of information from early buyers to the remaining majority via interpersonal communication. This paper summarizes this approach and presents four alternative perspectives. Then through these five perspectives, it interprets interpersonal interactions observed within the social networks of six households participating in a multi-week plug-in hybrid electric vehicle (PHEV) trial in Sacramento, California.

DOI would label a PHEV as a technological “innovation” (Rogers 2003) due to its physical and functional differences from conventional vehicles, i.e. using electricity to propel the vehicle, and from hybrid vehicles, i.e., adding battery capacity and the ability to recharge the battery from the electrical grid. However, consumer perceptions are more complex and amorphous than DOI allows. Table 1 presents a conceptualization of PHEV attributes according to two dimensions: functional/symbolic and private/societal. PHEVs are innovations because of what they physically do, i.e., incorporating use of conventional fuels and electricity from the grid in a single vehicle. Consumers may interpret PHEVs as desirable according to their ability to save them money on transportation, to improve drivetrain reliability, or to simply improve the experience of driving. In addition, a new product can be innovative because it conveys a “different social meaning” than previous products (Hirschman 1981), where symbolic values have been found to play a role in vehicle use in general (Steg, Vlek et al. 2001; Steg 2005) and hybrid-electric vehicle (HEV) purchases in particular (Heffner, Kurani et al. 2007). PHEVs may also be innovations because they can benefit society. Purely private goods are characterized by “exclusive and personal consumption and individual payment,” and public goods are characterized by “nonexclusive consumption and collective payment” such as “clean air” (Green 1992). Arguably, motor vehicles are primarily perceived as private goods consumers and other stakeholders (Canzler 1999). PHEVs could be defined as “mixed goods”—having aspects of both private and public goods (Green 1992)—providing both private mobility and symbolic benefits and public goods through reductions in air pollution, greenhouse gas emissions and oil dependence, or by encouraging others to think of and act on such issues. If so, behavioral researchers must consider the private-functional and symbolic and pro-societal attributes of PHEVs and other electric-drive vehicles.

**TABLE 1 Conceptualization of PHEV attributes (hypothetical examples)**

	<b>Functional</b>	<b>Symbolic</b>
<b>Private</b>	<ul style="list-style-type: none"> <li>• Save money</li> <li>• Reliable</li> <li>• Fun to drive (experiential)</li> </ul>	<ul style="list-style-type: none"> <li>• Expression of self-identity</li> <li>• Convey personal status to others</li> <li>• Attain group membership</li> </ul>
<b>Societal</b>	<ul style="list-style-type: none"> <li>• Reduce air pollution</li> <li>• Reduce global warming</li> <li>• Reduce oil use</li> </ul>	<ul style="list-style-type: none"> <li>• Inspire other consumers</li> <li>• Send message to automakers, government, oil companies</li> </ul>

In addition, perceptions change over time: functional understandings are altered as more information becomes available; symbolic meanings change and new meanings emerge (Heffner, Kurani et al. 2007); and pro-societal benefits are negotiated as new perspectives, research, and

policies emerge (Gjoen and Hard 2002; Smith 2005; Calef and Goble 2007; Hess 2007). Thus, to study and anticipate the adoption and diffusion of electric-drive vehicles, research must acknowledge that different aspects of the innovation may be perceived as new and important by consumers over time.

Because humans are social beings, developing perceptions of functional, symbolic, and pro-societal attributes as well as purchase decisions are embedded in social processes. Only recently have transportation researchers begun to explore the role of social interactions in individuals' travel (Paez and Scott 2007; Carrasco, Hogan et al. 2008). As summarized by Heffner (2007), the dominant research approach in vehicle purchase behavior is based on the rational actor model—representing the consumer as an actor that chooses among available alternatives to maximize individual utility (e.g. Bunch, Bradley et al. 1993; Ewing and Sarigollu 2000; Potoglou and Kanaroglou 2007). Recent studies have attempted to include factors of social influence in such models for alternative fuel vehicles (e.g. Mau, Eyzaguirre et al. 2008; Struben and Serman 2008; Axsen, Mountain et al. 2009). However, these approaches rely on aggregated representations of behavioral dynamics loosely connected to empirical findings from diffusion research in other disciplines (e.g. Rogers 2003), and ultimately yield little insight into the role of social interactions in vehicle purchase behavior. The present study employs a qualitative research design to explore such social processes in-depth to yield new insights and to help guide future research efforts. Three research questions guide this paper:

1. What are the main perspectives on the role of social influence?
2. How do these perspectives characterize the social interactions that influence consumer perceptions of functional, symbolic, and pro-societal attributes?
3. Which of these perspective(s) are most realistic and useful in regards to advancing research in transportation behavior?

## **2. LITERATURE REVIEW: FIVE PERSPECTIVES ON SOCIAL INFLUENCE**

This section discusses five theoretical perspectives on these research questions, categorized according to the assumed process of social influence: contagion, conformity, dissemination, translation, and reflexivity.

Contagion, or point-to-point influence, includes the most common approach to the adoption of new technologies: DOI. Diffusion is “the process in which an innovation is communicated through certain channels over time among the members of a social system” (Rogers 2003). The social system is divided into adopter categories based on empirical observation of adoption rates following a bell-curve over time for certain innovations, corresponding with the circularly-defined trait of innovativeness: “the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of the social system” (Rogers 2003). The adoption process is driven by communication from innovators (members of the first group to adopt an idea) and early adopters (members of the second) to individuals in later categories. One exception occurs when a “chasm” between innovators and later categories blocks diffusion (Moore 1999). Despite its popularity, DOI has been criticized for many drawbacks, including its: unsuitability for predictive applications (Rogers 2003); inability to address the diffusion of multiple related innovations (“dependent diffusion”) or external forces of diffusion (“phantom diffusion”) (Blaut 1987); lack of emphasis on underlying motivations to adopt (Rogers 2003) including an over-reliance on the tautology of “innovativeness” as a personality trait (Hirschman 1980); and inability to account for dynamics among relevant social systems (Blaut 1987). In summary, while contagion and DOI may help to

conceptualize the diffusion of information regarding simpler innovations with static attributes, other approaches may be required to properly investigate more dynamic and complex ideas such as PHEVs.

Conformity includes models of individuals' thresholds. Such models break "with the notion of direct contagion to view potential adopters as responsive to the distribution of present adopters in the population" (Strang and Soule 1998). An individual's threshold is the proportion of the relevant social system that must engage in the behavior before the individual will join, and may vary according to the strength of ties with other individuals (Granovetter 1978) as well as physical proximity, structural equivalence, and other factors (Valente 2005). The social system consists of individuals with a distribution of thresholds: the first adopters are instigators with relatively low thresholds, and conservatives with higher thresholds adopt later or not at all (Granovetter 1978). Although this approach is typically silent regarding underlying forces of conformity (Granovetter 1978), threshold-based decisions may be linked to social learning theory—where individuals vicariously learn from the actions of others (Bandura 2006; Efferson, Lalive et al. 2008), as well as the societal pressures detailed in social norm theory (Cialdini 2003). Ultimately, although the conformity perspective may assist in conceptualizing the influence of trends on adopters, it does not explain the emergence of new behavior or innovations, nor does it explain where existing social norms come from, or how they can change. However, this approach may be relevant for innovations with new symbolic attributes, where an individual may look for a certain threshold of earlier adopters to assure the intended meaning of their action is sufficiently established and likely to be perceived in the desired way by social contacts.

Dissemination is "diffusion that is directed and managed" by an organized group (Rogers 2003), including processes of collective action in the provision of pro-societal goods. Rather than assuming that individuals act alone, collective action explains how motivated individuals can interact and collaborate to provide pro-societal goods that would not have been provided otherwise (Marwell, Oliver et al. 1988). The ultimate challenge of collective action is to establish a critical mass, defined as a "relatively small subset of a group interested in the provision of a public good to make contributions of time, money, or other resources toward the production of that good" in order to sustain more widespread action (Oliver, Marwell et al. 1985). For PHEVs, potential adopters that are interested in functional-social attributes may face such barriers; reducing pollution, greenhouse gases or oil use cannot be achieved by the individual alone, but relies on previous and subsequent decisions by others to adopt. Thus, a potential adopter might not just look to previous adopters for information, but may also assess the likelihood of further adoption. Success of further adoption may be improved by the intentional coordination among some critical mass of dedicated, resourceful, pro-societal car buyers. This group acts not only through adoption of the particular vehicle technology, but also by testing, promoting and assigning values to the vehicles. These groups may be formalized in some cases, as with "Plug-in America" as regards PHEVs, but may also exist as less formal networks.

Translation treats innovations as dynamic, socially-constructed artifacts (Bruun and Hukkinen 2003). At first, a newly introduced artifact has a high degree of interpretive flexibility; different social groups may have differing interpretations of its meaning and content which influences further technological development (Pinch and Bijker 1984). Eventually the stages of interpretive flexibility reach a state of closure and stabilization as the interpretations of various social groups converge (Bruun and Hukkinen 2003), or in some cases remain in a less definitive state called alignment (Callon 1991; Hannemyr 2003). As a new technology is introduced and

developed, the social groups themselves may be redefined and transformed, such as through grouping around a certain cause or idea (Kline and Pinch 1996), and the entire social system itself may shift in response to the technology in question (Law 1992; Law and Hassard 1999). Adoption is driven by translation, where new ideas and objects change as a result of context and interactions among actors (Pentland and Feldman 2007). For some applications, translation may be a more accurate representation of how complex ideas spread among actors and social groups, similar to Blaut's (1987) concept of crisscross diffusion, where reinvention is a continuous aspect of communication between social actors. An example can be drawn from Heffner et al.'s (2007) exploration of HEV symbols: although several common symbolic denotations were discovered among early HEV buyers, each individual would translate such denotations into unique, personally relevant symbolic connotations.

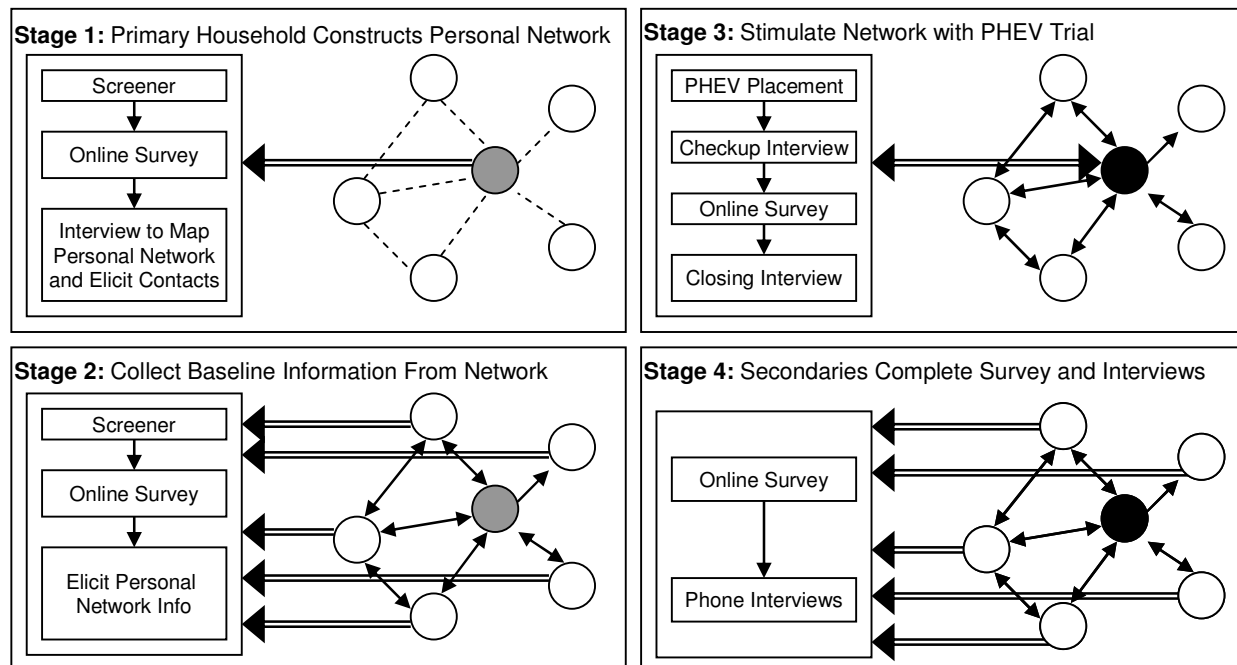
Reflexivity is drawn from Giddens' (1991) structuration approach to the relationship between self development and social structures in an uncertain, modern social world lacking the roles and expected behaviors enforced by tradition. In this modern world, individuals must actively seek out and define their self identity, taking on "a reflexive project" (Giddens 1991). Here, reflexivity is narrowly taken to be the dynamic, continuous, self-aware process of defining and expressing oneself (ignoring for the purposes of this paper the more general institutional reflexivity that is one characteristic of modernity in Giddens' approach). An individual's behavior is guided by efforts to establish a sense of order, direction, and development for their self-identity. As part of this project, individuals seek a lifestyle as a package of practices that are associated with their particular trajectory, such as fashion, eating, or any other "means of symbolic display." In Giddens' (1991) framework, the adoption of a pro-societal innovation may not just be driven by a motivation for advantageous functional or symbolic attributes, but may also be one component, or trial, of a more fundamental shift towards an environmental or socially-conscious lifestyle. Such a pattern may fit with Bartiaux's (2008) hypothesis that "environmentally friendlier practices raise the probability of other such practices and the openness to environmental information." The apparentness to others of a pro-societal car could facilitate reflexivity by prompting both its users and observers to share and negotiate interpretations. Observers may speculate as to the motivations and lifestyle choices of the user, assessing if such a practice might fit into their own self-trajectory. After adoption, a user may solidify their initial interpretations of the vehicle, or modify interpretations based on their experiences and feedback from personal contact and the media. Thus, similar to translation, and unlike contagion and DOI, the social context is subject to continuous uncertainty and revision of interpretations and meaning.

### **3. METHODS AND DATA: OBSERVING SOCIAL INFLUENCE**

The social interactions in vehicle purchase behavior—of a vehicle that may provide benefits in all four quadrants of Table 1—in the social networks of eight households participating in a PHEV demonstration project conducted at the University of California, Davis were interpreted through the above perspectives. The PHEV is a Toyota Prius converted to allow the recharging of an additional 5 kWh battery using any 110-volt outlet. Each household's trial lasts 4 to 6 weeks. Researchers worked with each of these six households to map, measure, and stimulate episodes of social interaction within the households' social networks.

Social network analysis has been frequently applied to diffusion studies; instead of emphasizing the individual as the unit of analysis it explores the role of linkages between individuals (Rogers 2003). Social network analysis investigates how the structure of these

linkages (or ties or relationships) influences the diffusion process (Granovetter 1973; Degenne and Forse 1994). While it may be ideal to study social processes and structure at the “total” network level—by accounting for every link among all individuals in a social system—in most situations it is only feasible to collect data from different personal networks (Degenne and Forse 1994; Carrasco, Hogan et al. 2008). A personal, or egocentric, network is represented by: i) the primary individual (the grey and black circle in Figure 1), ii) the other individuals they are socially connected to (the white circles), and iii) characterizations of the relationships between all individuals (the connecting arrows) (Carrasco, Hogan et al. 2008). In this study, we differentiate between the “primary” households that serve as the center point in a given network, i.e., those households actually driving a PHEV, and the members of their social networks they recruit to be “secondary” participants, who complete separate interviews and questionnaires.



**FIGURE 1 Stimulating Social Networks with a PHEV trial**

Eliciting personal network data can be challenging, including efforts to scope network size, overcome limitations in respondent recall, and mitigate respondent burden (Marsden 1990; Carrasco, Hogan et al. 2008). In this project, we use a technique outlined by Hogan et al. (Hogan, Carrasco et al. 2007), which assists participants in the creation of a sociogram—a graphical depiction of their personal network. Participants are asked to generate a list of “very close” and “somewhat close” contacts—terms kept intentionally vague—on a series of post-it notes, then arrange the names on a poster with four concentric circles representing social closeness. To explore these networks in depth, this study follows a “multi-method” approach (McCracken 1988) including structured interviews and internet-based questionnaires, as well as social episode diaries—the latter of which can be invaluable to enhance recall of interactions with other contacts during a particular period (Degenne and Forse 1994). The four stages illustrated in Figure 1 were implemented as follows. [A more complete description of this methodology is available (Kurani, Axsen et al. 2009)]



In stage 1, primary households were selected from a sampling frame consisting of American Automobile Association (AAA) members in the Sacramento area recruited for a PHEV demonstration study currently in progress at UC Davis. Along with being screened for eligibility and completing an online questionnaire, primary households engaged in an extended face-to-face interview designed to elicit their: 1) vehicle purchase history, 2) future vehicle purchase intentions (if any), and 3) social network. Primary households were then instructed to personally invite members of their network to take part in the study, and were asked to report any discussions of PHEVs or other vehicles that took place over the multi-week trial in a social episode diary.

In stage 2, the primary household recruited members of their personal network to complete the study (secondary participants). Secondary participants completed the same screener and internet-based questionnaire as the primary household.

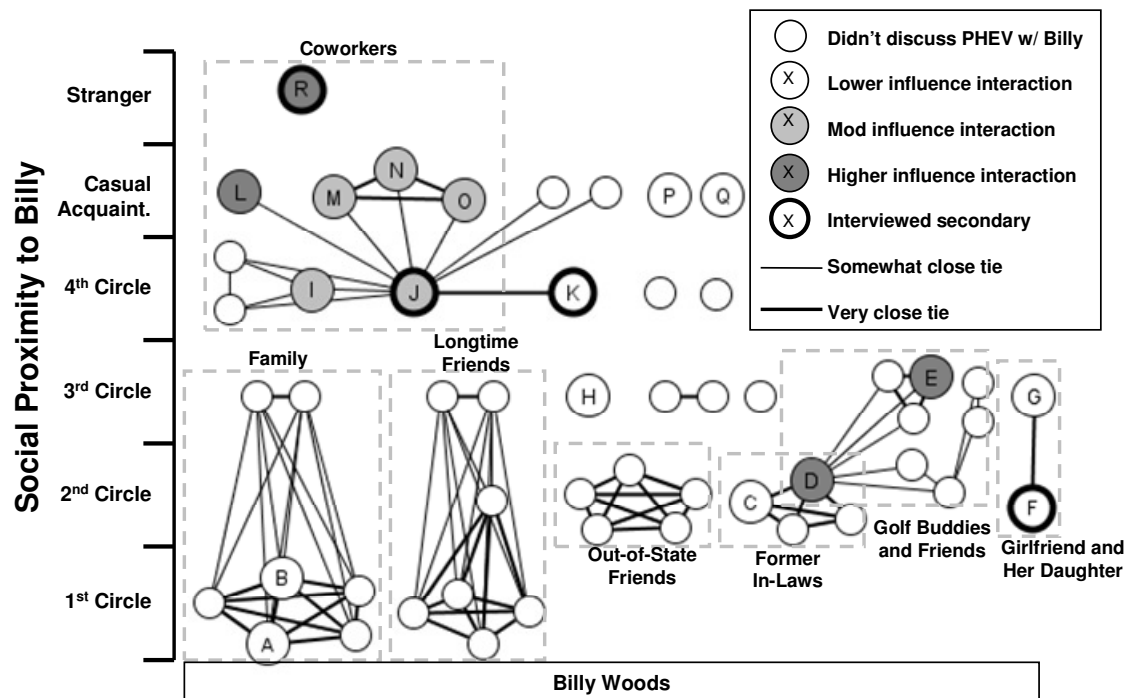
In stage 3, the primary household began their 4 to 6 week trial of the PHEV. During this time, each primary household completed several tasks, including regularly updating their social episode diaries and taking part in bi-weekly interviews. The closing interview elicited a narrative of the household's overall experience with the PHEV, including: recharging, driving and fueling behavior; functional, symbolic, and pro-societal interpretations of the vehicle; the dynamics of these interpretations over the course of their trial; and interests in future vehicle purchases. In this final interview, primary households also described social episodes (discussions, dialogues or other contacts) that took place within their personal network or beyond, then rated the perceived influence of these episodes over their assessment of PHEV technology.

In stage 4, secondary participants were again contacted to share their observations of the primary household's PHEV trial. All secondary participants completed the online PHEV design questionnaire, which also elicited information about any social episodes that occurred with the primary household during the trial. Secondary participants also took part in a telephone interview eliciting details of any experience with the PHEV, interpretations of the vehicle over the primary household's trial, specific social interactions with the primary household or others during the trial, and interests in future vehicle purchases.

Using this methodology with the social networks of eight primary households, 31 individuals were interviewed (13 primary participants, and 18 secondary) and over 190 social interactions germane to the PHEV were examined. As an illustration, Figure 2 portrays the sociogram of Billy Woods (pseudonyms are used for all participants). Billy identified 44 people as "very close" or "somewhat close" as categorized on the y-axis—circles closer to Billy, i.e., closer to the bottom of the figure, represent a closer social relationship to Billy. Billy mentioned or discussed the PHEV with 11 of these contacts during his trial (letters A through K), as well as eight casual acquaintances (letters I through Q), and one stranger (letter R). Figure 2 groups Billy's social contacts according to his descriptions of how close they are to one another (line thickness is proportional to strength of ties). Individuals recruited as secondary participants are identified with a thicker circle (F, J, K and R). Finally, the darker shading in circles indicates that Billy considered interactions with those individuals to have had relatively higher influence on his assessment of PHEV technology.

Table 2 summarizes the eight primary networks, including the primary households and the secondary participants they recruited. Table 2 also represents the primary households' perspective of the social proximity of the secondary participants (1<sup>st</sup> to 4<sup>th</sup> circle of "closeness," casual acquaintance, or stranger) and the influence of interactions with them (low, moderate or

high), as well as the secondary respondents' perspectives of social closeness and interaction influence (which do not always correspond with the primary households' perspectives).



**FIGURE 1** Billy Woods' Sociogram

#### 4. RESULTS: THREE PATTERNS OF SOCIAL INFLUENCE

While Figure 2 and Table 2 provide interesting overviews of some general patterns of social interaction, they exclude important details. One starting point for differentiation among these interactions is the networks themselves, which include individuals engaged in different lifestyle practices, resulting in different levels of experience with, and interest in, electric-drive vehicles, “green” technology, and pro-societal behavior. The eight networks in Table 2 are divided into three categories, each of which is illustrated with the story of one household.

**TABLE 2 Summary of primary households and secondary participants**

Primary HH info.	Total close	Close intrcts.	Total intrcts.	Participant (primary) <sup>1</sup>	Age	Household income	Demonstrated lifestyle practices	Relation to primary	For primary:		For secondary:	
									Social proxim. <sup>2</sup>	Infl.	Social proxim.	Infl.
<i>E-drive novices with private lifestyle</i>												
<b>The Noels:</b>	101	29	31	<b>Rupert</b>	40s	\$80-89k	Family					
				<b>Amy</b>	40s	\$80-89k	Family					
				John	60s	\$125-149k	Family/tech.	Coworker	4 <sup>th</sup> circle	Mod	Casual	Mod
				Ray	20s	\$70-79k	Family	Friend	3 <sup>rd</sup> circle	High	Very close	Mod
				Anita	30s	\$125-149k	Family	Friend	1 <sup>st</sup> circle	Mod	Very close	High
<b>The Petrovs:</b>	26	15	26	<b>Adam</b>	60s	\$40-49k	Construction/tech.					
				<b>Katrina</b>	30s	\$40-49k	Student					
				Pavel	20s	\$30-39k	Rec./tech.	Son	1 <sup>st</sup> circle	High	Very close	Low
<b>Betty Earhart:</b>	24	6	17	<b>Betty</b>	30s	\$50-59k	Work/family					
				Hazel	40s	\$50-59k	Family	Friend	Casual	Low	Some. close	Mod
				Macy	20s	\$70-79k	Student	Daughter	1 <sup>st</sup> circle	High	Very close	Low
<i>E-drive novices exploring pro-societal lifestyle</i>												
<b>Billy Woods:</b>	44	11	18	<b>Billy</b>	40s	\$100-124k	Rec.					
				Pat (F)	40s	\$70-79k	Family	Girlfriend	2 <sup>nd</sup> circle	Low	Very close	High
				June (J)	40s	\$80-89k	Rec.	Friend	4 <sup>th</sup> circle	High	Very close	High
				Chris (K)	40s	\$80-89k	Rec.	Friend	4 <sup>th</sup> circle	n/a	Very close	High
				Harry (R)	40s	\$125-149k	Enviro./tech.	Coworker	Stranger	High	Stranger	Low
<b>The Rancheros<sup>3</sup>:</b>	26	13	15 (20)	<b>Ed</b>	30s	\$100-124k	Family/tech.					
				<b>Silvia</b>	30s	\$100-124k	Family					
<b>Ethel Potter</b>	36	18	25	<b>Ethel</b>	50s	>\$150k	Family					
				Jane	20s	\$40-49k	Rec.	Daughter	1 <sup>st</sup> circle	Mod	Very close	Low
				Christy	20s	n/a	Student/rec.	Daughter	2 <sup>nd</sup> circle	Low	Very close	Mod
				Tom	30s	\$70-79k	Construction	Son-in-law	3 <sup>rd</sup> circle	Low	Very close	Mod
<i>E-drive enthusiasts with pro-societal lifestyle</i>												
<b>The McAdams:</b>	50	14	31	<b>Craig</b>	40s	>\$150k	Enviro./tech.					
				<b>Siobhan</b>	40s	>\$150k	Enviro.					
				Hannah	30s	\$20-29k	Enviro.	Friend	1 <sup>st</sup> circle	Mod	Very close	High
				Steve	40s	>\$150k	Enviro./tech.	Friend	1 <sup>st</sup> circle	Mod	Very close	Mod
				Donna	20s	\$20-29k	Unknown	Coworker	Casual	Low	Some. close	Mod
<b>The Rhodes:</b>	49	23	26	<b>Larry</b>	40s	>\$150k	Fam./enviro./tech.					
				<b>Cheryl</b>	30s	>\$150k	Fam./enviro.					
				Nicole	50s	\$100-124k	Fam./enviro.	Neighbor	3 <sup>rd</sup> circle	Low	Some. close	Low
				Betty	30s	\$100-124k	Fam./enviro.	Friend	3 <sup>rd</sup> circle	High	Some. close	Low

<sup>1</sup> Letters correspond to those in Figure 2, <sup>2</sup> Smaller numbered circles represent closer social ties.<sup>3</sup> A sociogram was elicited from Ed Ranchero only. "Total contacted" value in brackets includes 5 additional interactions reported by Silvia Ranchero

#### **4.1 Electric-drive novices expressing private lifestyle practices: The Noels**

Rupert and Amy Noel live with their three young children. They are family-oriented—devoted to their children and frequently interacting with their large extended family (recording 101 “close” members of their social network in Table 2). The Noels had no experience with electric-drive vehicles prior to their PHEV trial and they have no electric-drive experts within their social network. Throughout their trial, Rupert’s interactions mainly consisted of “showing off” the vehicle to others friends and coworkers, and he reported these interactions had little influence on him. In contrast, Amy more actively attempted to advance her functional understanding and assessment of the PHEV by eliciting the perceptions of friends, family, coworkers, and even her dentist. Above all else, the Noels’ agreed that the most influential interactions they had were in sharing their PHEV experience with their own children, such as adding the words “hybrid” and “plug-in” to their 4-year-old’s vocabulary. In all their conversations with members of their personal network, the Noels’ talked only about basic private-functional aspects of the PHEVs, e.g. recharging and fuel economy. These concepts were not well understood by the Noels or clearly communicated to others—all interviewed secondary participants (John, Ray and Anita) were unsure of the differences between the PHEV conversion and a regular Toyota Prius, and none had a strong sense of what benefits the vehicle offered, beyond generally improved fuel economy. At the end of their trial, the Noels primarily interpreted the PHEV as a good way to save money and avoid trips to the gas station—so long as such a vehicle could comfortably fit their children.

#### **4.2 Electric-drive novices exploring pro-societal lifestyle practices: Billy Woods**

Billy Woods is recently divorced and lives alone in a detached home. He engages in many social and recreational activities—frequent golfing, skiing, and visiting bars and night clubs. As a self-described “social guy,” he discussed the PHEV extensively within his large social network, including his technology-oriented coworkers at a computer company. He explored the PHEV’s “bells and whistles” with June (“J” in Figure 2), a close work friend and mentioned the car to other coworkers, golf buddies, and family. Many of his conversations consisted of “small talk” and “showing off” the PHEV’s private-functional attributes, and he considered such interactions to be of low influence on him. For Billy, his most influential interaction took place with an electric car owner at work, Harry (“R”), who was concerned the PHEV might overload the circuit they were sharing to recharge their vehicles at the workplace parking lot. This interaction was Billy’s only contact with an electric-drive expert—a man who built his own electric car and charged it at home via a solar array. The conversation didn’t progress beyond a brief functional explanation by Billy of the PHEV demonstration, yet Billy rated the interaction as highly influential because Harry had discussed the PHEV within a larger perspective of alternative fuel vehicle research, including hydrogen fuel cells. At several points in his trial, Billy demonstrated open-mindedness to exploring pro-societal attributes of the PHEV. He polled several coworkers, asking them which would provide the greater motivation to purchase a hybrid: the ability to save money or save the environment. These coworkers served as one of Billy’s most influential reference groups, and after they responded that saving money was more motivational, Billy agreed. Billy also added that he would prefer a plug-in truck, or at least a car that looked more attractive than the Prius.

#### **4.3 Electric-drive enthusiasts expressing pro-societal lifestyle practices: The McAdams**

Craig and Siobhan McAdam have strong environmental and pro-societal values which are demonstrated throughout their home including solar panels, efficient light bulbs, and a hybrid

Toyota Prius in their driveway. Craig sees the PHEV as an extension to his Prius, i.e., a way to further reduce their environmental impacts and dependence on foreign oil, as well as sending a message to automakers to support the technology. The McAdams' social network includes people with similar pro-societal values and some interest in advanced technology—Craig has already influenced at least three of them in their purchases of Toyota Priuses. Surprisingly, the PHEV trial did not stimulate many “real conversations” in the McAdams' network; Craig and Siobhan explain that because environmental issues and actions are already such a big part of their lives, the trial of a converted Prius did not have an enormous impact. Two secondary respondents in the McAdams social network (Hannah and Steve) described how they already have ongoing dialogues with Craig about different environmental technologies and were already aware of PHEV conversion kits—the McAdams' PHEV trial was just another experience in lifestyles they regarded to be pro-societal. Craig also mentioned his PHEV trial to more socially distant coworkers, but he found them to be generally disinterested—a fact that the McAdams' found to be disappointing.

## **5. DISCUSSION: CHARACTERIZING PATTERNS OF SOCIAL INFLUENCE**

The above stories and their supporting data can be used to draw out preliminary answers to the three questions posed in Section 1. Results suggest that social interactions within networks constrained to people known to each of the primary households in this study can play an important role in a household's assessment of a PHEV. Seven of the eight primary households described at least one social interaction that they ranked as being highly influential over their assessment (the other household ranked several interactions as being moderately influential). Among other things, such interactions included the seeking of help in understanding private-functional attributes, polling the private versus societal motives of others in an effort to work out one's own lifestyle priorities, and efforts to disseminate pro-societal values. The qualitative evidence gathered in this study supports the notion that investigating social interactions is worthwhile for researchers of vehicle purchase behavior specifically and perhaps transportation behavior more broadly. To explore deeper, this section describes interactions from the five perspectives of contagion, conformity, dissemination, translation, and reflexivity. Table 3 summarizes these perspectives as interpreted from the primary households.

### **5.1 Contagion**

Contagion views social influence as the result of a primarily unidirectional flow of functional information. For example, Billy Woods frequently informed people he was driving a PHEV and briefly explained that it was different from a regular Toyota Prius. In another example, Rupert Noel's work supervisor (John in Table 2), learned from Rupert that the PHEV had reasonable acceleration capabilities: “I was always wondering about that issue of having enough guts so that you don't get run over...so I was impressed.” Such interactions could be described as instances of diffusion, where information diffuses from the primary household to a secondary participant, and subsequently influences the latter's assessment of PHEV technology.

However, the contagion perspective neglects many subtle but important nuances of interpersonal influence. One criticism of this perspective is that functional information is not the only thing shared during social interactions. Billy Woods did use several social interactions to inform his own functional perceptions of the PHEV. However, his conversation with Harry brought Billy into contact with a broader perspective on mobility: “he's the one that pointed out the hydrogen technology...he just opened up some questions...[that] I couldn't answer.” In contrast, Harry initially saw Billy's PHEV as a signal that such technology was finally

“commercially broadly available....I was hoping that this was someone who would be driving this as an everyday driver” (until he learned that Billy was only participating in a short-term trial). Further, when Billy polled his coworkers about environmental motives, he wasn’t collecting functional information about PHEV technology, but rather was testing how a certain perspective and lifestyle might fit in with one of his reference groups. Interestingly, social interactions that are limited to the passing of functional information, tend to be rated by participants as being less influential over their overall PHEV assessment, such as Billy Wood’s and Rupert Noel’s descriptions of non-influential “small talk.”

A further criticism of the diffusion perspective is the limiting assumption of unidirectional information flow from innovators toward the majority. Billy, an electric-drive novice, and Harry, an electric-drive enthusiast, each described their exchange as bi-directional. Similarly, while it may be tempting to label the McAdams as electric-drive “innovators,” even they learn from, and exchange information with, others (and others who are not “innovators”) on an ongoing basis. Primary households and their network members did not generally draw their perceptions from one particular “innovator” or set of experiences. Rather, they formed a general understanding of the PHEV through an ongoing discourse of social interactions that they integrated with their existing background knowledge.

## 5.2 Conformity

Conformity views social influence as being derived by an individual’s perceptions of what others are doing. This perspective illustrates that parting from certain norms can be undesirable or desirable. Billy Woods describes that although he generally liked the PHEV, he thought the Prius design was ugly, and as a “single guy” he didn’t want to drive downtown “in a car that looks like an egg.” Billy was not describing a particular interaction, but a general perception of the expectations and norms of one of his reference groups—the night club crowd—that a car should be attractive. June, a secondary participant in Billy’s network, echoed this sentiment, describing that her household would prefer a PHEV that was more “normal” than the “funny-looking” Prius design. The McAdams also highlight the importance of supporting the existing norms of their social network. However, because their network consists of individuals with pro-societal motives, where “the idea of...plugging in a car is not that... ‘Jetsons’ to our group of friends,” driving the Prius PHEV actually supported these norms. (The Jetsons<sup>®</sup> was a futuristic cartoon television show in the US first produced in the 1960s.) On the other hand, the Noels’ excitement about their PHEV trial was at least partially derived from its lack of conformity; they describe how driving the PHEV would “turn heads” because it was a “status symbol” potentially in a sense of wealth as well as environmental motives.

While the conformity perspective helps to conceptualize the influence of current trends and social pressures on individual adopters, it does not explain how such trends emerge and develop. For example, conformity alone does not help researchers to understand why the Prius style is unappealing to one of Billy’s reference groups, but is at the same time appealing to one of the McAdams reference groups.

## 5.3 Dissemination

This sample does not include any participants that are members of any formal groups of PHEV dissemination. Further, while Billy Woods and the Noels did describe “showing off” the PHEV in many instances, such interactions were not dissemination—they were more of a reaction to the novelty of the PHEV trial.

However, the McAdams described themselves as advocates for electric-drive technology, where Craig explained one motive for buying his Prius: “I wanted to put my money in my beliefs...and buy a hybrid car to help promote the production of further hybrid cars...that year they were making....100,000 and now they’re making 400,000 because there were those of us that bought them five...years ago.” Siobhan added that within their network, Craig “has single handedly sold multiple Priuses.” One of these fellow Prius buyers was Donna, a friend of the McAdams that Craig had helped to realize that she was “much more comfortable sending that money off to Toyota who has hired scientists and engineers to design this car...[which] promotes better choices among drivers.” In this sense, the dissemination perspective addresses the intentional diffusion of information by electric-drive enthusiasts. Such enthusiasts see that their pro-societal goals are more achievable if they expend effort to test, promote and assign value to the vehicles to positively influence future buyers. However, while the dissemination approach does more explicitly account for pro-societal motives than contagion, it does not directly address the formation and spread of pro-societal values.

#### **5.4 Translation**

In contrast to the previous three perspectives, translation does not simply conceptualize social influence as the transfer of information or the perception of others’ behavior. Translation highlights how individuals engage in interactive, ongoing dialogues in which they interpret, negotiate and redefine what PHEVs mean to them, and potentially to other groups, or society. Translation allows social interactions to play a role in the formation and development of interpretations, whether functional, symbolic or pro-societal.

From the perspective of translation, participants with less electric-drive experience are generally in a state of greater interpretive flexibility: the Noels were coming to terms with the basic functions of the PHEV, and became excited when someone made the simple observation that it allowed them to “make less trips to the gas station.” To reach this understanding, Amy Noel continually sought the perspectives of others in her network to help her form and refine her own functional understanding of the PHEV. Similarly, Billy Woods partially formed his functional understanding of the PHEV from interactions with some of his friends and coworkers, but also become interested in talking to others about (and in a sense negotiating) the broader interpretations of electric drive—private, e.g. saving money, versus pro-societal, e.g. environmental motives. This dialogue helped Billy to solidify his interpretation of the PHEV as way to save him money. The translation perspective acknowledges that some participants begin their PHEV trial with relatively open minds, and their ultimate interpretations of the PHEV are in part informed by interactions with others.

In contrast, those participants with more knowledge about electric-drive vehicles are approaching a state of interpretive closure. The McAdams had already reached a state of interpretive closure prior to their PHEV trial, understanding PHEV technology to represent the same pro-societal values already portrayed by their (non-plug-in) Toyota Prius.

**TABLE 3 Characterizing interpersonal interactions for each primary household**

Network:				Approach:	
	Contagion	Conformity	Dissemination	Translation	Reflexivity
<i>E-drive novices with private lifestyle</i>					
The Noels	Telling others the PHEV saves trips to the gas station.	Perceiving the PHEV as “turning heads,” as a “status symbol.”	None observed.	Interpretive flexibility: learning about different private-functional benefits of the PHEV, such as “less trips to the gas station.”	Becoming vaguely aware of a pro-societal lifestyle trajectory, but remaining far more concerned with family-oriented living, emphasizing vehicle space and cost savings.
The Petrovs	Telling others about their PHEV trial.	Perceiving the Prius as a more “age appropriate car” for Katrina.	None observed.	Interpretive flexibility: assessing the PHEV’s performance and learning that it would not save them money because the battery was too unreliable.	Approaching his PHEV trial as another handy-man project, Adam uses his own expertise to assess if the vehicle is a practical, efficient way to meet their transportation needs. In contrast, as a recent immigrant and current student, Katrina learns from friends and links PHEV technology to her home culture.
Betty Earhart	Telling others about her PHEV trial.	Perceiving that like her, others in her network also wanted to save fuel, but keep an SUV model.	None observed.	Interpretive flexibility: assessing the PHEV’s performance, and determining that it would fit her driving patterns, though she would need an SUV model.	As a business minded person, Betty wanted to determine if the PHEV could save her money while meeting the needs of her job. Her focus on financial savings was reinforced throughout her social network. Thus, driving a PHEV could fit into her current lifestyle trajectory.
<i>E-drive novices exploring pro-societal lifestyle</i>					
Billy Woods	Explaining how the PHEV differs from an HEV.	Perceiving that the Prius PHEV is not attractive enough for the bar/club scene.	None observed.	Interpretive flexibility: asking others if cost savings or environment is more important motive for purchasing a PHEV.	Using the PHEV to learn more about a pro-societal lifestyle trajectory, but remaining more engaged and interested in his recreational lifestyle.
The Rancheros	Telling coworkers how 80% of CO <sub>2</sub> emissions come from power plants (which he heard on a news program).	Discovering that the PHEV did not fit in with the “gas guzzlers” and muscle cars owned by their network	None observed.	Interpretive flexibility: shifting economic and family priorities over environmental concerns after discovering the PHEV is too small for their family, and inconvenient and unsafe to recharge.	Shifting from being a single man interested in pickup trucks and sporty cars, Ed’s recent marriage and young child have prompted him to shift towards being a “family guy.” They want to preserve the environment for their daughter’s future, but don’t want to sacrifice safety, economics or comfort in the meantime.
Ethel Potter	Telling her family about her PHEV trial.	Finding others’ within her network that also wanted to have a positive enviro. impact.	None observed.	Interpretive flexibility: wondering if a PHEV would be good for the environment given battery toxicity and electricity emissions.	Ethel saw the PHEV as a way to have a positive environmental impact. Empowered by her trial, she subsequently increased her commitment to environmental practices, such as scheduling home installation of solar panels.



**TABLE 3 Characterizing interpersonal interactions for each primary household (Continued)**

Network:	Approach:				
	Contagion	Conformity	Dissemination	Translation	Reflexivity
<i>E-drive enthusiasts with pro-societal lifestyle</i>					
The McAdams	Telling others about their PHEV trial.	Seeing the PHEV as fairly normal in their social circle.	Advocating electric-drive technology, and buying a Prius to promote further production of green technology.	Interpretive closure: seeing the PHEV is an extension of their Prius—pro-environment and supporting green technology.	Remaining fully engaged in a pro-societal lifestyle, where PHEV is just another stage of the trajectory—supporting further production, but not as big a step as purchasing their conventional Prius.
The Rhodes	Detailing the fuel economy of the PHEV relative to their HEV.	Feeling an added sense of “fitting in” with a pro-environmental reference group by driving the Prius.	“Spreading the word” about PHEV technology to improve the technology—also taught a preschool class on batteries.	Interpretive closure: seeing the PHEV is a good way to reduce oil use, but renewable electricity source is needed to make it truly “green.”	Remaining fully engaged in a pro-societal lifestyle, using the PHEV to further “spread the word” about green technology—seeing the PHEV as a “stop-gap” to clean technology, and encouraging pro-societal values in the next generation

## 5.5 Reflexivity

The reflexivity perspective complements the translation perspective by linking the participant's PHEV interpretations to their "reflexive project of the self" and lifestyle practices. Other perspectives assign individuals to static categories: contagion has earlier and later adopters, conformity has instigators and conservatives, dissemination has a critical mass, and translation has relevant social groups [although certain applications of translation have allowed for dynamics in the social system itself, e.g. Kline and Pinch (1996)]. However, reflexivity illuminates the reality that lifestyle trajectories are not static for an individual, but are, like interpretations, constructed, shared and negotiated over time.

The apparentness of the PHEV can facilitate reflexivity by prompting users and observers to share and negotiate not just interpretations of the technology, but also lifestyle trajectories. Of particular interest in the present study, the reflexivity perspective helps to identify which types of households and social network may be more amenable to developing new, pro-societal interpretations of vehicle technology. Three main factors are highlighted: i) the household's current lifestyle practices, and whether they are in a state of transition, ii) the household's base level of understanding (or access to understanding) of functional aspects of PHEV technology, and iii) the prevalence of supportive pro-societal values within the household's social network. These factors can be illustrated with the three household's introduced in Section 4.

The Noels were not initially interested in pro-societal attributes of the PHEV, nor did they become significantly interested by the end of their PHEV trial. The Noels are firmly entrenched in a family-oriented lifestyle; home, children, and careers are stable; no vehicle purchases are anticipated; they participate in, and by doing so help to create, an active extended family. At the beginning of their trial, they had little idea of what a PHEV was or how it worked, and thus devoted more time and effort towards learning basic functionality. During their trial, it became clear that the Noels do not have any strong connections with environmental and pro-societal groups; they are far more integrated into a family-oriented community, so they focus on the family aspects of the PHEV, such as enjoying the excitement of their children and judging they would need a PHEV larger than the Prius to accommodate their family.

At the time of his PHEV trial, Billy Woods' lifestyle trajectory was susceptible to change. He recently became divorced, bought a new home, and seemed to be searching for new ways to spend his time and prioritize his values which included recreation and social activities. To an extent, Billy uses his PHEV trial as an opportunity to try an alternative lifestyle trajectory and learn more about how it fit within his current trajectory as represented by his social network—demonstrated by his query to coworkers about their private versus pro-societal motives. Relative to the Noels, Billy had more background knowledge about electric drive, and general familiarity with technology (possessing an engineering degree and working for a computer company), as well as having access to several people with appropriate knowledge in his social network. However, Billy ultimately rejects prioritizing pro-societal motives (at least for now) after failing to find support among one of his most influential reference groups—coworkers—and so concludes with primarily private interpretations. Opportunities presented by his PHEV trial, as well as recent changes in his lifestyle, allowed Billy to try on a new lifestyle, and he reflexively determined that it did not fit.

The McAdams see themselves already fully engaged in a pro-societal lifestyle. They first began to seriously engage this trajectory several years ago, after moving from the East Coast to a city in Northern California known for pro-societal values. Having researched hybrid vehicle and other pro-environmental technologies for year, Brian was already an electric-drive "expert," and the McAdams had already constructed and become integrated within a network of dedicated pro-

societal people. Ultimately, their PHEV trial was not viewed as being particularly novel for the McAdams or their network—more like business as usual in a pro-societal lifestyle trajectory.

In summary, from the perspective of reflexivity, when participants talk about the PHEV, they not only share information about the technology, they are also sharing information about different identities and ways of living—the incorporation of which adds a more rigorous, and behaviorally realistic, theoretical backdrop to the other four research perspectives.

## **6. CONCLUSIONS: DIRECTIONS FOR BEHAVIORAL RESEARCH**

Preliminary results suggest that interpersonal interactions within households' social networks play an important role in shaping consumer assessment of these PHEVs, and likely electric-drive vehicles more generally. In efforts to characterize how social interactions influence vehicle assessment and adoption behavior, contagion (including diffusion of innovations), conformity, and dissemination provide useful concepts for particular processes, but translation and reflexivity appear to better provide the language and theoretical depth required to integrate the various motives and perceptions observed among participating social networks. Further, contagion, conformity, and dissemination hold important variables constant: contagion assumes unidirectional flow of information between groups statically defined on “innovativeness”; conformity only describes the current pressures and norms of a given social system; and dissemination focuses on a core group of pro-societal lifestyle practitioners. In contrast, translation and reflexivity acknowledge the ongoing negotiations and development of interpretations, values, and lifestyle practices associated with evaluating an innovation.

In this study, the reflexivity perspective illuminated which households and social networks may be more amenable to developing new, pro-societal interpretations of vehicle technology—particularly those households that: i) are in a liminal state of their lifestyle practices, ii) already have a basic understanding of functional aspects of PHEV technology, and iii) find supportive pro-societal values within their social network. Themes derived from this exploratory, qualitative study can guide future transportation behavior and policy research as follows: social interactions are important to the shaping of peoples' values, and the study of social interactions can benefit from the development and use of more in-depth, behaviorally realistic research perspectives.

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