Title

Interpersonal Influence within Car Buyers’ Social Networks: Observing Consumer Assessment of Plug-in Hybrid Electric Vehicles (PHEVs) and the Spread of Pro-Societal Values

Author
Axsen, Jonn

Publication Date
2010

Interpersonal Influence within Car Buyers' Social Networks:
Observing Consumer Assessment of Plug-in Hybrid Electric Vehicles (PHEVs)
and the Spread of Pro-Societal Values

By

JONN AXSEN
B.B.A. (Simon Fraser University) 2004
M.R.M. (Simon Fraser University) 2007

DISSERTATION

Submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Transportation Technology and Policy

in the

OFFICE OF GRADUATE STUDIES

of the

UNIVERSITY OF CALIFORNIA

DAVIS

Approved:

____

Kenneth S. Kurani

____

Thomas S. Turrentine

____

Daniel Sperling

Committee in Charge
2010

Abstract

Consumer purchase behavior is central to the successful deployment of alternative-fuel passenger vehicles, which includes non-rational processes such as social influence. This dissertation explores the role of social influence in vehicle purchase behavior via observations of car buyers' assessments of plug-in hybrid-electric vehicles (PHEVs)—vehicles that can use gasoline and grid electricity. Five theoretical perspectives on social influence are used to analyze these behaviors: contagion, conformity, dissemination, translation, and reflexivity. I designed and implemented a multi-method, exploratory research design to engage households in semi-directed interviews, online surveys, a social-network mapping exercise and a diary of social episodes. Participants included 10 "primary" households (18 individuals) that drive a PHEV for a multi-week trial in the Sacramento, California region, and 22 "secondary" individuals that primary households recruit from their social networks.

The analysis explores three questions: i) whether or not social interactions influence vehicle assessment and purchase behavior, ii) how such social influence occurs, and ii) under what conditions pro-societal motivations might develop. First, I find that social interactions do have substantial influence over the majority of participants' assessments. Second, contagion and similar theoretical perspectives over-simplify processes of social influence, while translation and reflexivity better provide the language and theoretical depth required to integrate the observed perceptions and social processes with concepts of self-identity. Third, car buyers that are typically motivated by the private benefits of vehicles may be amenable to developing new, pro-societal interpretations of PHEVs

when they: i) are in a transitional (liminal) state in their lifestyle practices, ii) can quickly form a basic functional understanding of PHEV technology, and iii) find supportive pro-societal values within their social network.

A theoretical contribution of this dissertation is an integration of theoretical perspectives with my empirical observations to create a framework representing the role of social influence in purchase of pro-societal goods—what I call the Reflexive Layers of Influence (RLI) framework. Overall, this dissertation demonstrates that social influence is important, as is the development and use of behaviorally realistic theoretical frameworks to advance transportation and energy policies that rely on the widespread adoption of new technologies.

Executive Summary

The question of how and why consumers buy new products is central to the successful deployment of alternatively fueled and propelled vehicles—and the adoption of sustainable consumption practices in general. Although the rational actor model dominates research on transportation behavior, behavioral economists, psychologists and sociologist have long established that consumers do not typically follow "rational" decision processes (e.g. Thaler and Sunstein, 2003; Tversky and Kahneman, 1974). This dissertation explores the role of *social influence* (or interpersonal influence) as one determinant of consumer purchase behavior. The context for this study is the assessment and adoption of *plug-in hybrid electric vehicles* (PHEVs) as one incarnation of electric-drive vehicle.

What are PHEVs and how are they new to consumers?

A PHEV is a combination of a hybrid-electric vehicle (HEV)—which uses only gasoline—and an electric vehicle (EV)—which uses only electricity. A PHEV user could power their vehicle with electricity from the electrical power grid and/or gasoline (or another liquid fuel). Policymakers are increasingly viewing PHEV technology as a means to meet environmental and energy goals in transportation. From a consumer's perspective, PHEVs can be perceived and valued according to two dimensions (Table E-1). First is the *functional/symbolic* dimension (Hirschman, 1981). Functional benefits relate to what the PHEV can physically do for the consumer, such as reducing gasoline costs and engine noise. Symbolic benefits relate to what the PHEV can represent, such as expressing the buyers' environmental or nationalistic identity, or helping them to fit in with a certain social group. The second dimension is *private/societal* (Green, 1992), which concerns who receives the benefit: the individual or household (private benefits), or the community, nation, or society at large (societal benefits). Each individual may value PHEVs based on different attributes within this framework, and their perceptions will change as they are exposed to and learn more about the vehicle technology.

Table E-1: Conceptualization of PHEV attributes (hypothetical examples)

	Functional	Symbolic
Private	• Save money • Reliable • Fun to drive (experiential)	• Expression of self-identity • Convey personal status to others • Attain group membership
Societal	• Reduce air pollution • Reduce global warming • Reduce oil use	• Inspire other consumers • Send message to automakers, government, oil companies

Because humans are social beings, perceptions of functional, symbolic and pro-societal attributes as well as purchase decisions are firmly embedded in social processes. Yet only very recently have transportation researchers begun to explore the role of social interactions in individual transportation decisions. The dominant research approach is based on the rational choice model of discrete choice—representing the consumer as an actor that chooses among available alternatives to maximize their individual utility. However, in reality consumers do not typically act in isolation, nor do they typically follow rational, deliberative decision processes when they purchase a vehicle.

Research questions

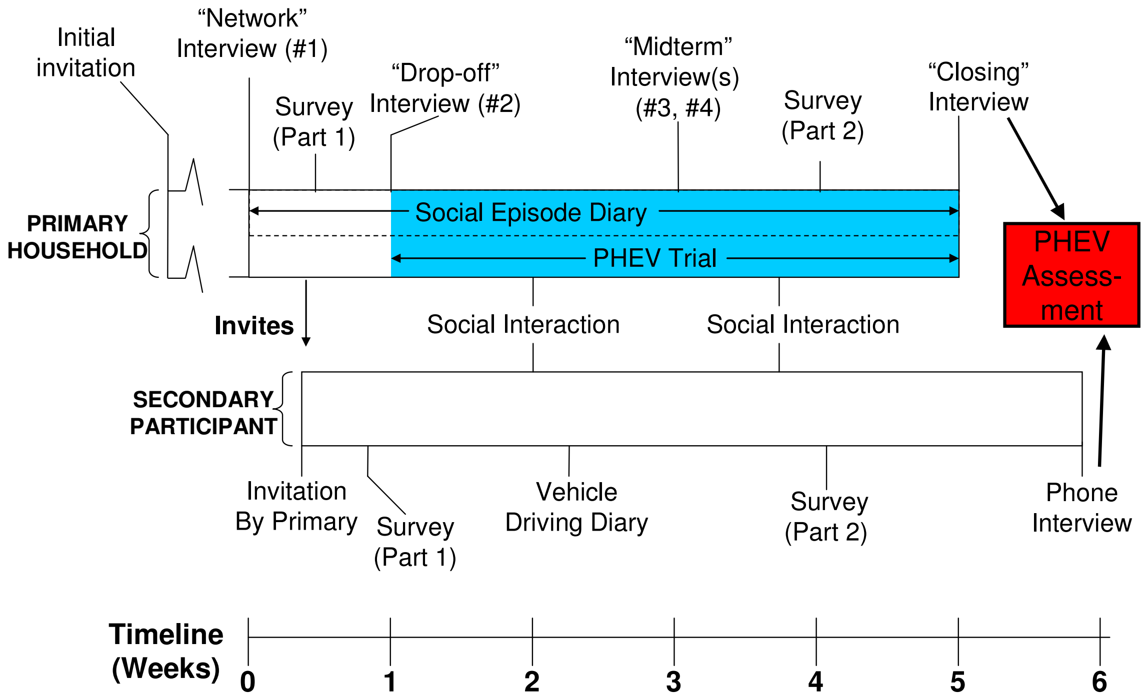
This dissertation explores the role of interpersonal influence in the formation and stabilization of such perceptions, considering three main research questions:

1. Does interpersonal influence play a significant role in the adoption of electric drive vehicles?
2. If so, how can we characterize the interpersonal processes that impact consumer perceptions of functional, symbolic and pro-societal attributes?
3. Under what conditions might households adopt electric drive vehicles and the pro-societal car? (And how might policy create those social conditions?)

Methods: Mapping, stimulating and observing social Networks

To collect empirical data on social influence, I designed and implemented a multi-method, qualitative research project. Working with a PHEV demonstration project conducted in the Sacramento, California region, I utilized a subset of 10 participating households. Research instruments included a series of semi-structured interviews, a two-part online survey, a social network construction exercise, a social episode diary and an influence ranking exercise. An approximate timeline of the research design is depicted in Figure E-1. In the first interview, each of the 10 "primary" households were instructed to construct a map of their social network, then to recruit several of their friends or family (or other *alters*) to take part as "secondary" participants. Next, the primary household substituted a PHEV for their current vehicle for a multi-week trial. They recorded any social interactions that pertained to the PHEV in a social episode diary, and described these interactions in subsequent interviews. In the final interview, the primary household assessed the PHEV technology, then ranked how influential different experiences were in their PHEV assessment. In total, 10 primary households (18 individuals) and 22 secondary participants took part in the project. This "sample" includes participants with a wide variety of demographic, socioeconomic, and attitudinal characteristics—approximating the distributions of larger, representative samples of car buyers used in several previous studies.

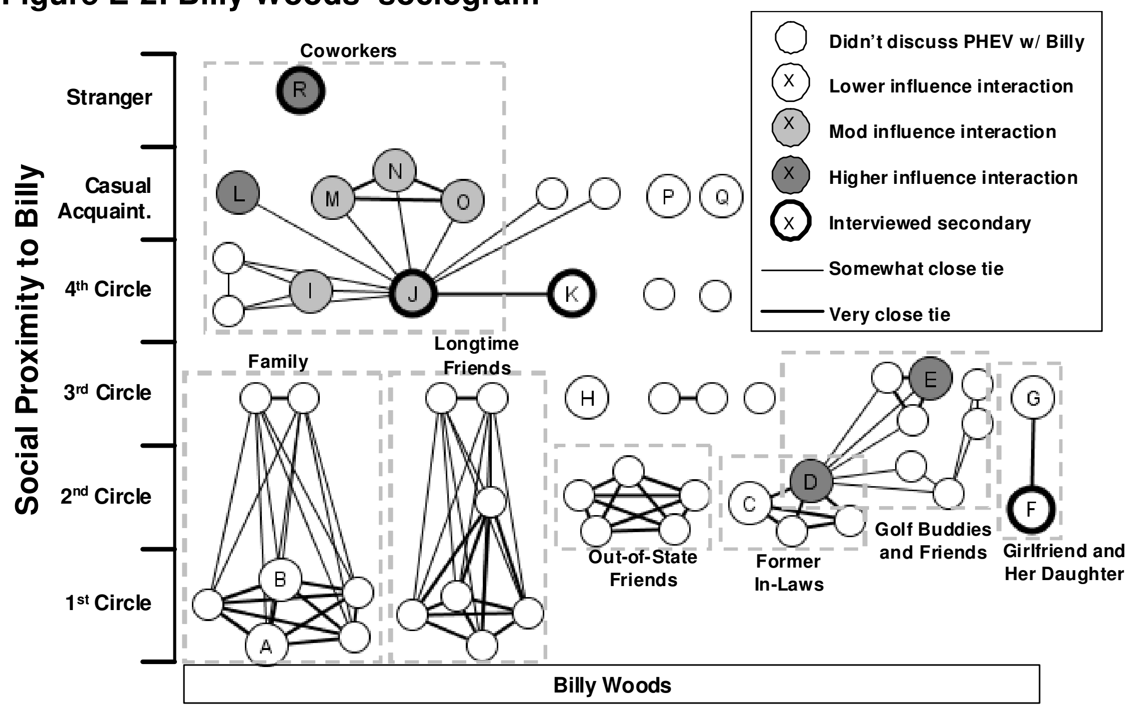
Figure E-1: Timeline of research design (approximate)



Results

Figure E-2 illustrates the types of results flowing from this dissertation using the social network of one primary household, Billy Woods, as well as the social interactions observed within his network during his PHEV trial. Billy identified 44 people as *very close* or *somewhat close*, i.e. within the first four circles of his network (the y-axis in Figure E-2). Billy mentioned or discussed the PHEV with 11 of these alters during his trial (A-K), eight casual acquaintances (I-Q), and one stranger (R). Recruited secondary participants are identified with a thicker circle (F, J, K and R). The darker shading in a circle indicates that Billy rated interactions with that individual to have had relatively higher influence on his assessment of PHEV technology. The number of identified alters and social interactions differed across the ten primary households.

Figure E-2: Billy Woods' sociogram



From each participating household's interview and survey data I construct a *narrative* of their PHEV trial. Box E-1 is an example of an abbreviation of the narrative elicited from Billy Woods. The narrative follows a chronological, causal flow of experiences and events. It begins with the participant's background information and expectations of the study. Next is the household's PHEV trial experience, including driving and recharging the vehicle, as well as talking to various alters. Finally, the household concludes with their overall assessment of the PHEV technology, which may or may not differ from their initial expectations. I analyze each narrative to explore the five perspectives of social influence gleaned from previous literature, and to further look for patterns that help explain why some households develop pro-societal values, while others don't. Results suggest answers for each of the three research questions I set out to explore.

Box E-1: Billy Woods tries on a new lifestyle

The beginning: A bachelor lifestyle
Billy is a single man in his mid-forties living alone in a detached home in Sacramento. After an "amicable" divorce a couple of years ago, Billy's bachelor lifestyle is suggested by his décor: a surfboard in the backyard; a dining room dominated by a large putting green, a counter-mounted wine opener, and liquor dispenser; and a living room with a large flat-screen TV. Billy describes himself as a social guy who will typically "make friends pretty easy," and he identified 44 alters in his social network (Figure E-3). He completed degrees in civil engineering and business, and he currently earns a six figure income as a public relations person at a computer company. He owns a 1995 Lexus ES 300 which he bought used from his sister and currently uses for commuting—although he often works from home—as well as an older pickup truck he occasionally uses on weekends, and a small Harley Davidson motorcycle.

Prior to participating in this study, Billy had little familiarity with his current energy expenditures, including gas and electricity use. He also had no previous experience with "electric-drive," not even a Prius, and didn't initially understand the differences between an HEV, PHEV and EV. He expected the PHEV itself to be "sluggish, not to perform like a regular combustion engine." Billy also anticipated that he would talk to many people about the PHEV—when researching something new, he would typically "toss it to other people to see what their thoughts are, if it is worthwhile…some suggestions."

The trial: Showing off, exploring and polling others
Throughout his trial, Billy learned about the PHEV through experiences with the technology itself, as well as through some of his 18 social interactions. At first, Billy would initiate conversations to "show off" the vehicle; he called his **sister (B)** and **Mother (A)** to tell them about the study but discovered his mother had little concept of hybrid vehicles, and his sister was unimpressed that the car was "just a Prius." During these and other "small talk" conversations, e.g. with **co-workers (L-O),** his **bartender (P),** his **barber (Q)**, Billy engaged in a general "intro" pattern, briefly describing the study, how the car was special, and then answering some basic questions.

Billy also had more meaningful experiences that helped him to learn about the technology. He faithfully substituted the PHEV for his Lexus, commuting to work most weekdays, running errands, and driving to golf on weekends. He quickly concluded that driving the PHEV was "really no different from any other car," except for perhaps being quieter. When it came to performance, Billy "was not disappointed at all" and was impressed with the vehicle's "pick-up" and acceleration capabilities: "it had some power, it could get to speed…just like any other car." However, he noted some drawbacks, such as when his golfing buddy, **Albert (D)** pointed out that at higher speeds, "you can actually hear the engine almost racing…like it was trying to power up…it left some kind of worry."

Billy talked frequently about the PHEV with his coworker and friend, **June (J),** who helped him experiment with many of the Prius' features, such as the energy monitor. Billy also spent some time playing with the monitor on his own, and would often watch it to judge the PHEV's state of charge and to see when the vehicle was using gasoline or electricity

Billy plugged in the PHEV as often as he could. He recharged at home almost "every night…just plug it in and go to bed." Although he didn't initially know he could recharge at work, **June (J)** encouraged him to look more aggressively—he then discovered a special spot reserved for EV recharging and moved his car there after lunch that day. From then on, he plugged in nearly every day at work. Billy also plugged in at his girlfriend **Pat's (F)** house on two occasions.

Throughout his trial, Billy highlighted the PHEV's potential to save money. However, he never made "an entire assessment." He tried to calculate savings based on the cost of filling the tank, but ultimately he couldn't quantify fuel savings beyond the general notion that "it uses a lot less gas." Billy was more comfortable framing fuel savings according to vehicle's range with a full tank, as with his story of a trip to Monterey with **Pat (F)**:

> *"just before I went to Monterey, (the tank) was pretty much empty…I thought I could make the entire trip…didn't quite make it…[but] it was in excess of 400 miles…that was really cool…[it shows] you get more bang for the buck…that was neat to see, really cool."*

While Billy primarily focused on the "bang for your buck" aspect of fuel saving, he also highlighted a specific conversation with several of his "opinionated" **co-workers (M, N, O)** as particularly influential. After seeing a question on the online survey, Billy had become interested in societal motives. He then took this question to his coworkers:

> *"[I asked them] why would you buy a hybrid? Mainly to protect the environment, or from a consumer standpoint?…and all of them said if it costs less I'll buy it, basically it's all consumer…and that's what I answered on the survey… to buy it just to protect the environment is probably not something I'd do at this time… I'll look at buying something that would have less of an impact on my pocket book more than anything else."*

Near the end of his trial, Billy plugged the PHEV into the same circuit that was being used by another coworker, **Harry (R),** that built and drove his own EV (converted from an old Volkswagen Rabbit), which led to a phone conversation between them [see Harry's perspective in Box 3]. Billy was impressed that Harry's EV had a retractable cord, which made him think that manually coiling the PHEV extension cord was a bit "hokey" and vulnerable to theft. Billy was most excited about Harry's expertise regarding alternative fuel technology:

> *"[Harry was] very influential because he was really encouraging about this technology…and he's the one that pointed out the hydrogen technology…he just opened up some questions…(that) I couldn't answer…(I'm) already thinking that electricity might already be outdated…if they're exploring other technologies."*

PHEV assessment: Saving money at 50 mpg

By the end of his PHEV trial, Billy was impressed with the PHEV. His emphasis was on getting "more miles per gallon, from a cost savings standpoint." While Billy feels that achieving 100 MPG would be "cool," he was happy enough with around 50 MPG, which is "just ideal because I'm comparing it to what my motorcycle gets, so if I can get at least that much that would be great." For Billy "the exciting part of it is the electrical part."

However, Billy clearly expressed reservations about what kind of plug-in vehicle he would want to own, outlining several inclinations that ultimately favored a truck design. He wants a vehicle that is stylish like a truck: as a "single guy…I'm not going to drive midtown in something that looks like an egg." He also values the practicality, versatility and safety he associates with trucks. Further, Billy expresses uncertainty as to whether PHEVs represent the future of technology, particularly after **Harry (R)** mentioned the potential for hydrogen. Billy likens vehicles to computers, describing alternative-fuel advancements as a progression of upgrades to conventional vehicles: "people are with hybrids today…[now] potentially a plug-in…and then, all of a sudden maybe that hydrogen technology will outlast what you [researchers] are offering here."

Result #1: Social influence does matter. The first question implicitly asks if social influence is worth researching in the first place. Results clearly indicate that yes, in the context of this study, social influence does matter. Of the 10 primary households, nine identify at least one social interaction as being at least moderately influential over their assessment of the PHEV—and the one remaining household explained that social influence had occurred during their previous vehicle purchases (just not in the context of their PHEV assessment). Thus, all households yield evidence that social interactions play an important role in vehicle assessment. Further investigation of the observed social interactions, e.g. via logistic regression analysis, suggest that interactions between the primary household and a given alter tend to be rated as more influential when: pro-societal aspects of the PHEV are discussed, the alter has more functional understanding of electric-drive technology than the primary participant, and the primary and alter are socially close (in a general sense).

Result #2: Social influence is driven by diffusion, translation and reflexivity. In Chapter 2 I identify five general research perspectives on social influence and consumer behavior (Table E-2). *Contagion* emphasizes the importance of the unidirectional flow of information, as in diffusion of innovations (DOI) (e.g. Rogers, 2003). *Conformity* accounts for how an individual is influenced by their perceptions of what others around them are doing or expecting (e.g. Granovetter, 1978). *Dissemination* describes how groups of resourceful, pro-societal individuals can coordinate to intentionally diffuse positive information about a pro-societal product or technology—known as a critical mass (e.g. Oliver, et al., 1985). *Translation* represents how social groups can negotiate different interpretations of a new technology, eventually reaching a state of agreement and influencing the development of the technology in the process (e.g. Law and Hassard, 1999; Pinch and Bijker, 1984). Lastly, *reflexivity* describes how individuals work to arrange their various lifestyle practices, such as the purchase and operation of a vehicle, into a meaningful trajectory that effectively communicates their self-concept, which is itself mediated and negotiated through of such practices (Giddens, 1991).

Table E-2: Comparing alternative perspectives on interpersonal influence and adoption behavior

	Contagion	**Conformity**	**Dissemination**	**Translation**	**Reflexivity**
1. What is the innovation? (static/dynamic)	Innovation (static)	Behavior (static)	Collective good (static)	Artifact (dynamic)	Lifestyle practice (highly dynamic)
2. System boundaries? (static/dynamic)	Social system of potential adopters, (static)	Relevant social group (static)	Social system, critical mass (static)	Relevant social groups: (dynamic)	Social system, lifestyle sectors, (highly dynamic)
3. Who adopts first?	Innovators and early adopters	Instigators	Organizers	Social groups who perceive artifact as a solution	Those finding practice compatible with self concept
Why?	Higher "innovativeness"	Low threshold	High interest and resources	Interpretation of solution	Search for self-identity
4. Who adopts later?	Imitators, early to late majority, laggards	Conservatives, due to higher thresholds,	Non-organizers	Social groups that later reinterpret problems/solutions	Same as above
Why?	Lower "innovativeness"	High threshold	Efforts of organizers	Interpretive closure	Search for self-identity
5. What drives adoption?	Contagion: interpersonal communication of information	Conformity: motivation to mimic, learn from, or join others	Dissemination: willingness of organizers to achieve social good	Interpretation: perceived ability of innovation to solve a problem	Reflexivity: creating and sustaining self-identity
Best applied to what types of attributes?	Private-functional	Symbolic (private and societal)	Societal (functional and symbolic)	All	All

Of the five perspectives I find that contagion, conformity, and dissemination provide useful concepts for particular processes, but translation and reflexivity 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 (as seen with Billy Woods' consideration of pro-societal values in Box E-1). However, the notion of diffusion (categorized within the contagion perspective) is useful for describing and exploring the flow of simple, functional information relating to the PHEV—which proves to be an important foundational process in PHEV assessment. Thus, I conclude that processes of social influence are best characterized using concepts from three complementary perspectives: diffusion, translation, and reflexivity.

Result #3: Pro-societal values can be developed. I observe that four of the 10 primary household used their PHEV trial actively experiment with pro-societal values ("pro-societal explorers" in Table E-3). Two of these households (Woods and the Rancheros) concluded their PHEV trial with primarily private values (where they started), while the other two (Potter and the Forts) concluded with relatively stable pro-societal values (a significant shift from where they started). Through narrative analysis, I identify conditions that explain why some households consider pro-societal values, and of those that do, why some commit to pro-societal values while others do not. I identify three conditions—in the context of this PHEV trial, it appears that each condition is necessary (but not sufficient) for an initially privately-motivated household to shift towards pro-societal values and lifestyle practices.

Table E-3: Three patterns of interpersonal influence in social networks

Primary HH (**example**)	1) Liminality	2) Functional understanding: easily learn about PHEV?	3) Support from social network?
E-drive novices, "private lifestyle"			
The Noels:	Low	No	No
The Petrovs:	Mod	No	No
Betty Earhart:	Mod	Yes	No
The Stashes:	Low	Yes	No
Melissa Stashe:	High	No	No
E-drive novices, " pro-societal explorers"			
Billy Woods:	High	Yes	No
The Rancheros:	Mod	Yes	No
Ethel Potter	High	Yes	Yes
The Forts:	High	Yes	Yes
E-drive enthusiasts, "pro-societal lifestyle"			
The McAdams:	Low	Yes	Yes
The Rhodes:	Low	Yes	Yes

Lifestyle liminality (condition 1). If the household is not already engaged in a pro-societal lifestyle, their lifestyle must be *liminal* enough to permit them to consider alternatives to their current private lifestyle—that is, they must be in a relatively flexible, open-minded state regarding their self-identity. Liminality can be a temporary state of transition, as with a shock to the household such as a divorce, e.g. Billy Woods, or sustained, such as when a household's children grow up and move out, as the disposable income increases, or when the individual's self-concept is oriented towards flexibility and openness.

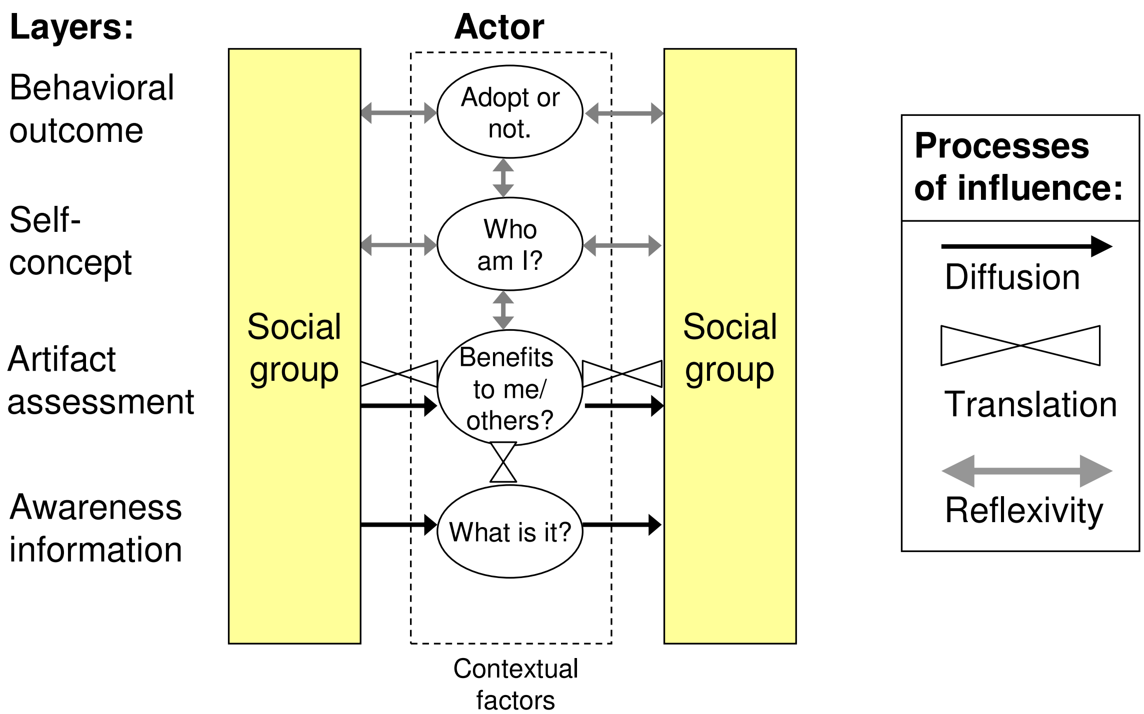
*Functional understanding (condition 2)***:** The second condition is a basic functional understanding of the PHEV technology. The household does not need prior experience or familiarity with electric-drive technology, nor do they need to be electric-drive experts or enthusiasts. However, an individual or household must at least understand what the PHEV does, i.e. how its function differs from a conventional vehicle, before they can form a stable assessment of who it is good for, that is, before they can frame its benefits according to private versus societal impacts. Having a technical background appears to facilitate quicker learning of these functional aspects.

Social support (condition 3): The third condition is the demonstrated support of pro-societal values within the household's social network. Among the households that explored pro-societal values, the presence or absence of such support is associated with their final interpretation of the PHEV. The two households concluding with private interpretations described a lack of pro-societal support in most key areas of their social network. For example, Billy Woods polled his coworkers about their motives to buy an HEV, and then sided with their financial (private) response. In contrast, the two households that concluded with pro-societal interpretations of the PHEV perceived social support for pro-societal values among alters they considered to be particularly influential.

Reflexive layers of influence (RLI) and policy implications

As a final stage to this dissertation I propose an integrative perspective on the role of interpersonal influence in adoption behavior, which I call reflexive layers of influence (RLI). This perspective represents four layers that lay beneath the "surface" of the observed vehicle purchase (Figure E-3). Building up from the bottom, these layers are: functional awareness, assessment of the technology (private and/or societal), self-concept, and behavioral outcome, e.g. purchase. The individual, household or social group in question is identified as an *actor*, while the technology in question is a socially-defined *artifact*.

Figure E-3: The basic RLI framework



Social influence follows different processes at different layers. Social influence impacts lower layers through the *diffusion* of simple information, such as awareness of the artifact in question. Social influence impacts the private and societal assessment layers through *translation*, where the actor interprets benefits of the artifact that relate to their interests and lifestyle practices. These assessments are *reflexively* linked to the actor's self-concept, which can both serve to frame the actor's assessment, and be reinforced or altered according to their assessment. This self-concept is reflexively linked to the apparent lifestyle practices of other actors, as well as the actor's purchase intention and eventual adoption behavior. All RLI layers are constrained by *contextual factors*, including the actor's life stage, disposable income, and need for a new artifact, as well as market availability, price, marketing efforts and government support. When the actor's assessment of the artifact aligns with their lifestyle trajectory and favorable contextual factors, they are more likely to adopt the artifact. The RLI perspective represents all of these layers as dynamic and subject to processes of social influence.

Policy implications

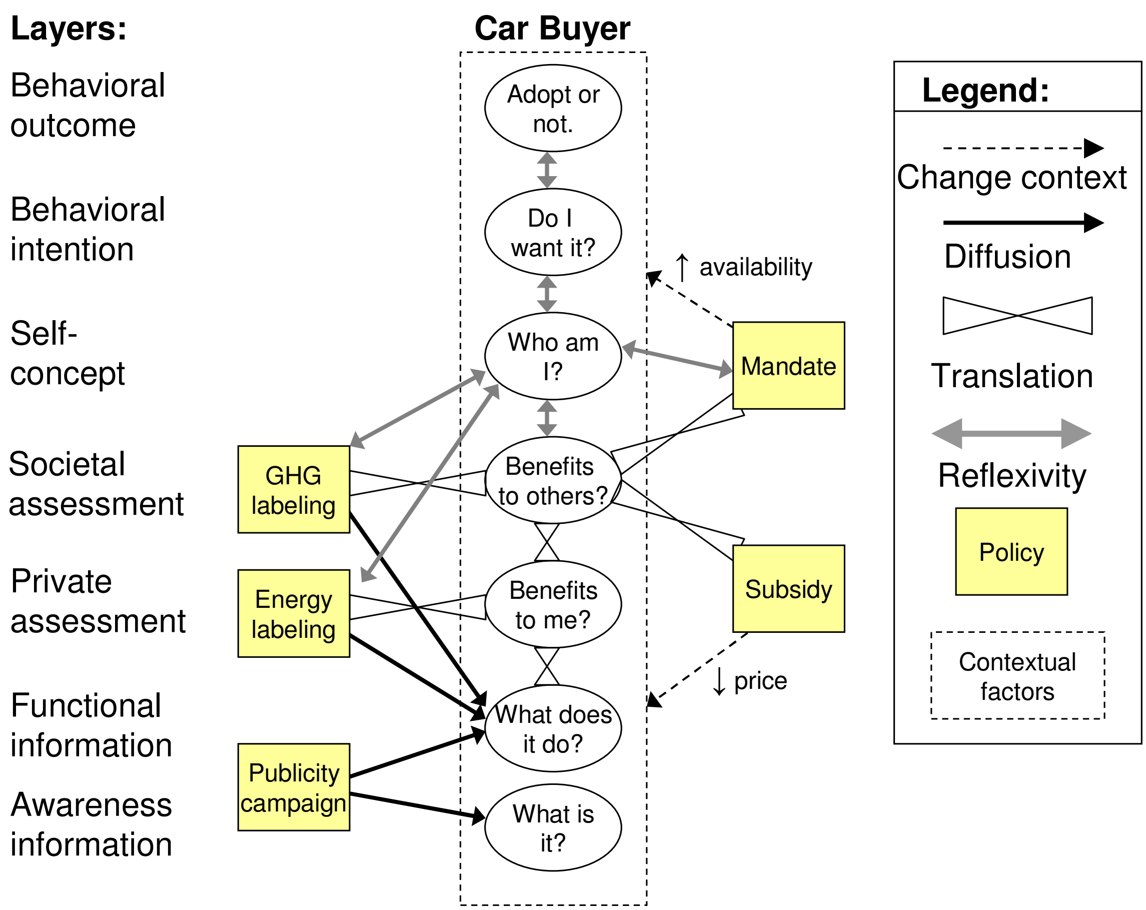
The dominant perspective on transportation behavior, the rational choice model, suggests only two levers for policymakers to influence consumer behavior: changing price (via financial incentives or disincentives) and providing functional information about the product or behavior. In contrast, this dissertation attempts to move beyond simplistic behavioral models, exploring a multitude of complex processes that influence human behavior. Social influence can be a very powerful lever: households can alter their values under certain conditions. Careful consideration of how different policies and types of information can influence the different RLI layers can help policymakers to better design policy, predict its effects, and measure its impacts (Thaler and Sunstein, 2003). In particular, policymakers might consider the differences between the processes of diffusion, translation and reflexivity.

The effects of almost any policy action can be considered using RLI (Figure E-4). A publicity campaign can attempt to intentionally diffuse, or disseminate, information about PHEVs in efforts to achieve societal goals, such as awareness of the technology and functional information about what it does. Policymakers might also disseminate this information through labeling standards, or energy information websites. Successful policy-driven diffusion may help to establish the awareness and functional understanding layers that are necessary for an actor to further assess the technology. However, diffusion alone tends not to significantly impact the individual's assessment, self-concept, or adoption. Translation describes a more sophisticated form of social influence where the actor develops a more refined and stable understanding of the PHEV, how it might benefit them personally, if it might benefit society, and (through reflexivity) if they should care if it benefits society. This study suggests that translation is more likely to occur at an interpersonal level, that is, through person-to-person interaction rather than from mass media sources, though it can also occur indirectly through other means.

Product labeling serves as one type of translation—where policymakers frame the PHEV according to particular benefits, such as cost savings (a private benefit) or GHG emissions (a societal benefit). Other policies may also be indirectly (or unintentionally) translated by actors. While a subsidy directly affects the price of a PHEV (a contextual factor in RLI), it may also help diffuse awareness about the technology, and also may be translated through considerations of why the subsidy is being offered, e.g. PHEVs are good for society, PHEVs are bad technologies that need government help, or the government is wasting tax dollars. Further, a government mandate, such as the Zero-

Emissions Vehicle (ZEV) mandate, can also contribute to the popular debate about what kind of vehicles consumers should desire, and whether they should emphasize private or societal benefits. In short, policymakers need to consider the variety of impacts of a given policy, including the differing processes of social influence, and RLI provides a useful framework to do so.

Figure E-4: Policy levers for social influence



Acknowledgements

The inquiries that drove the bulk of this dissertation were inspired by the continuing behavioral work of Drs. Ken Kurani and Tom Turrentine. In particular, Ken Kurani played a very integral and helpful role as advisor and guide. He encouraged me to pursue my research interests, and frequently and reliably set aside time to provide intellectual and emotional support in the design, implementation and analysis of this dissertation. Still, any errors in this document are my own responsibility.

I also thank the other staff and students of the Plug-in Hybrid Vehicle Research Center who helped with the development of this project, including Dr. Tom Turrentine, Nicolette Caperello, Tai Sillwater, Jamie Davies, Kevin Nesbitt and Marilyn Kempster.

Special thanks for my wife, Wendy, for the continued love and support.

Table of Contents

List of Abbreviations

AE	All-electric
ANT	Actor-network Theory
B	Blended
CARB	California Air Resources Board
CD	Charge-depleting
CS	Charge-sustaining
CV	Conventional vehicle
DOI	Diffusion of innovations
EV	Electric vehicle
GHG	Greenhouse-Gas Emissions
GM	General Motors
HEV	Hybrid-electric vehicle
ICE	Internal combustion engine
Li-ion	Lithium-ion
NiMH	Nickel-metal hydride
PHEV	Plug-in hybrid electric vehicle
RFI	Reflexive layers of influence
SCOT	Social construction of technology
SOC	State of charge
ZEV	Zero-Emissions Vehicle

1 Context: The Market for Plug-in Hybrid Vehicles

The question of how and why consumers buy new products is central to the successful deployment of alternatively fueled and propelled vehicles—and the adoption of sustainable consumption practices in general. Although the rational actor model dominates research on transportation behavior, behavioral economists, psychologists and sociologist have long established that consumers do not typically follow “rational” decision processes (e.g. Thaler and Sunstein, 2003; Tversky and Kahneman, 1974). This dissertation explores one potential determinant of consumer purchase behavior: *social influence* (or interpersonal influence). This first chapter sets the context for the particular type of sustainable consumption under study: the adoption of plug-in hybrid-electric vehicles as one incarnation of electric-drive vehicle. Later chapters delve into theories of consumer behavior and the details of the present research.

1.1 What is electric drive and why is it important?

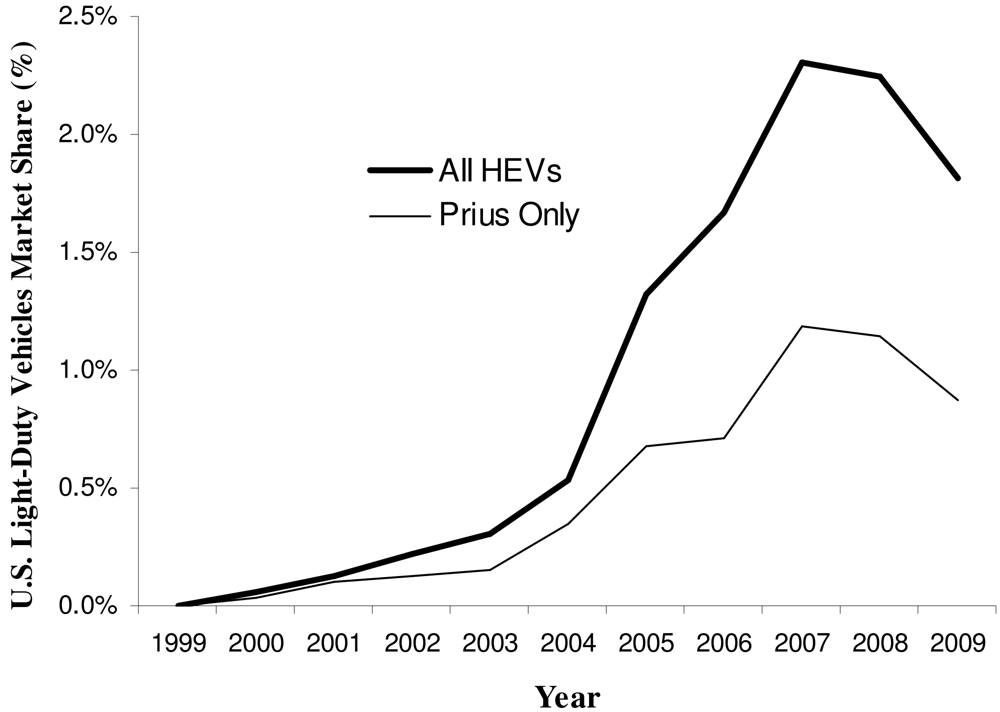
Spurred by petroleum supply and price disruptions, air pollution policy, and climate change policy, much effort and many resources have been devoted to the development of electric drive vehicles over the past three decades. The oil crisis of 1973-4 lead to substantial government funding of research on alternative fuels, including the Hybrid Electric Vehicle Act of 1976 which resulted in much of the electric vehicle technology developments that emerged during the 1990s (Turrentine and Kurani, 1996). Battery *electric vehicles* (EVs)—which are powered solely by an on-board energy storage system and recharged from an external grid—captured renewed attention in the 1990s, stimulated by General Motor's development of the EV-1 (*aka* Impact) and California's Zero-Emissions Vehicle (ZEV) mandate. In the late 1990s, after years of further technological development and policy debate, policymakers were convinced by automobile manufacturers that battery technology was insufficient to meet manufacturers' EV design goals. Since then, small markets have developed for EV applications with relatively limited range and top speeds, such as neighborhood or regional EVs.

Although the ZEV mandate failed to produce commercially viable EVs in the intended time frame, some battery technologies later proved successful in less demanding *hybrid-electric vehicle* (HEV) applications. HEVs are fueled by gasoline (or potentially another liquid fuel), combining a conventional internal combustion engine (ICE) with an electric motor and battery to improve the vehicle's overall fuel economy. Relative to other alternatively propelled vehicle technologies, HEVs have achieved significant commercial success over the last decade, typified by the Toyota Prius (see Figure 1).[1]

Currently, interest has turned to what many claim is the next logical step from the HEV: *plug-in hybrid electric vehicles* (PHEVs). The PHEV combines aspects of the EV and HEV, potentially operating like an EV for a limited distance, with the addition of an ICE to replace or supplement the electric motor to extend range and increase power. No commercial PHEVs are currently available in the US, but the technology is receiving attention from automakers, regulators, electric utilities and consumer groups.

[1] Declining market share in 2008 and 2009 may have more to do with economic recession than a decline in hybrid popularity per se.

Figure 1: US annual HEV new market share, 1999-2009



Source: USDOE (2009)

In particular, policymakers are increasingly viewing PHEV technology as a means to meet environmental and energy goals in transportation (Service, 2009). In response to the U.S. President's 2006 State of the Union address, the U.S. Department of Energy has published a working draft of a PHEV R&D Plan (USDOE, 2007). In California, the Air Resources Board amended the ZEV mandate in March 2008 to provide incentives for automakers to produce and sell PHEVs (CARB, 2008). More recently, President Obama set a national target to have 1 million PHEVs on the road by 2015 (Revkin, 2008), and as of the beginning of 2009, a federal tax credit of $2,500 to $7,000 is offered for the first 250,000 PHEVs sold (U.S.Congress, 2009).

Despite growing support, determining the environmental and societal impacts of PHEVs is complex and the benefits are uncertain; it is a new technology capable of a wide diversity of designs, driving and recharge patterns, and electricity sources. To date, many studies have attempted to calculate potential energy and environmental impacts (e.g. Axsen and Kurani, 2008; Duvall, et al., 2007; Gonder, et al., 2007; Hadley and Tsvetkova, 2008; Kang and Recker, 2009; Lemoine, et al., 2008; McCarthy and Yang, 2010; NAS, 2009; Samaras and Meisterling, 2008; Silva, et al., 2009; Sioshansi and Denholm, 2009; Stephan and Sullivan, 2008). Each study yields different results flowing from different assumptions about the type of PHEV in question, consumer driving patterns and recharge behavior, the source of electricity used by the PHEVs, and the baseline to which the PHEV should be compared, e.g. conventional vehicles or HEVs. Research generally indicates that PHEV use could halve petroleum use (Axsen and Kurani, 2008; Gonder, et al., 2007) and reduce greenhouse gas emissions (GHG) by one third (Samaras and Meisterling, 2008) to two thirds (Duvall, et al., 2007) relative to conventional vehicles. Under some conditions, PHEVs are depicted as being no more desirable from a GHG perspective than HEVs (e.g. Hadley and Tsvetkova, 2008; NAS, 2009; Samaras and Meisterling, 2008)—but such a comparison presumes that PHEVs would be replacing HEVs rather than some distribution of conventional and hybrid vehicles. Of course, all estimates of PHEV benefits stem from the uncertain assumptions noted above and, of central importance to this dissertation, uncertain assumptions of consumer purchase behavior. In any case, the strong potential for societal benefits suggests that PHEVs at least warrant further exploration.

1.2 Understanding PHEV technology

Relative to other electric-drive and conventional gasoline vehicles, one potential advantage of PHEVs is fuel flexibility. A user could power their vehicle with electricity from the electrical power grid, gasoline (or another liquid fuel), or both. To do so, a PHEV has both an electric motor and a heat engine—usually an ICE.[2] This flexibility also complicates vehicle designs and possible ways of using energy from two different systems. Figure 2 depicts two simple schematics of possible PHEV architectures, that is, the overall design of the PHEV system to supply power from two different sources. A *series* drivetrain architecture powers the vehicle only by an electric motor using electricity from a battery. The battery is charged from an electrical outlet, or by the gasoline engine via a generator. A *parallel* drivetrain adds a direct connection between the engine and the wheels, adding the potential to power the vehicle by electricity and gasoline simultaneously and by gasoline only. These two architectures are illustrated by the differing plans of two automakers: while Toyota is currently developing a PHEV with a parallel architecture, i.e. a plug-in version of the Prius, General Motors is working with a series architecture, i.e. the Chevy Volt.

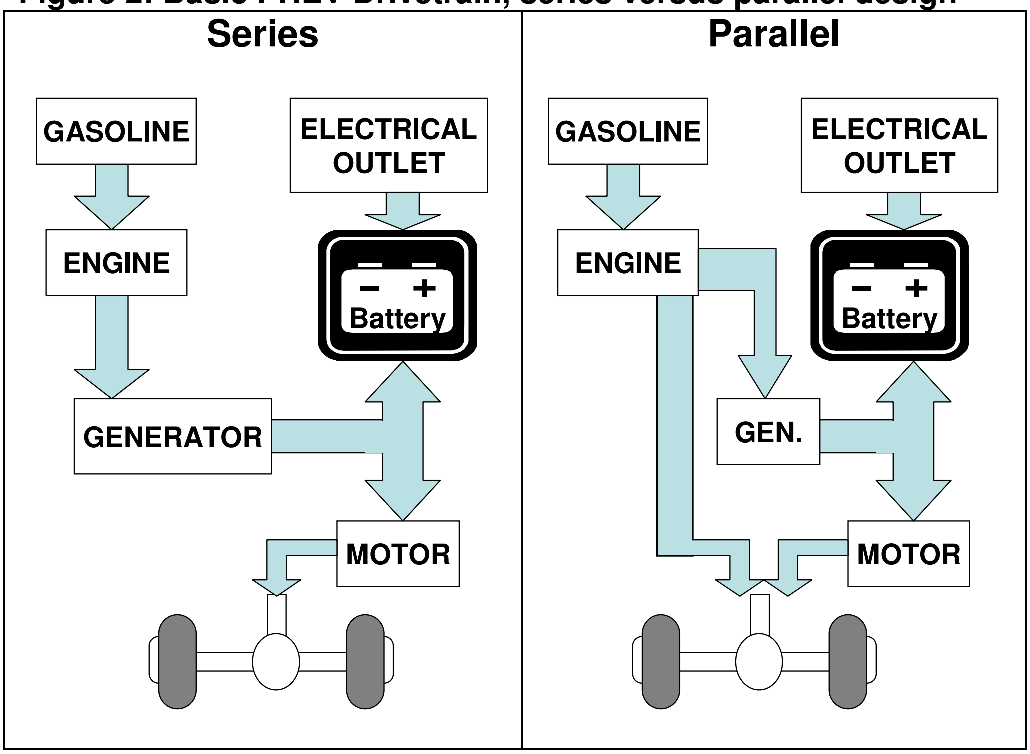
In any PHEV architecture the battery plays a crucial role in storing energy from the electrical grid and from the gasoline engine (through a generator), as well as passing energy back and forth with the electric motor to maximize efficiency. During braking and coasting, an electric motor can convert—or, regenerate—some of the kinetic energy of

---

[2] As the ICE in most conventional vehicles is fueled with gasoline (or diesel), I will refer to gasoline and gasoline engines without precluding the possibility of different future fuels.

the moving vehicle into electrical energy to be stored in the vehicle's battery. "Pure" EVs only have an electric motor and only run on electricity and thus need batteries that can store large amounts of energy and deliver high power. However, PHEVs can be designed to emphasize energy or power requirements (or both) of batteries.

Figure 2: Basic PHEV Drivetrain, series versus parallel design



In part, the commercial success of PHEVs depends on the development of appropriate battery technologies. There is much uncertainty about what exact requirements a battery must meet to produce successful PHEVs and where different battery technologies stand in meeting such requirements. On the one hand, electric drive advocate often claim that battery technology is sufficient to begin the commercial introduction of PHEVs immediately (e.g. CalCars, 2008; EPRI, 2007). On the other hand, some critics counter that substantial technological breakthroughs are required before PHEVs should be introduced to the market (e.g. Kromer and Heywood, 2007). One battery researcher states that commercialization prior to 2015 would present substantial business risk (Anderman, 2008). Also, as the difference in initial PHEV architectures between automakers shows, there is disagreement on what a PHEV is, or if the concept is flexible enough and the market diverse enough to support multiple incarnations. For their part, policymakers are unsure how to regulate PHEV emissions and "fuel" use under conditions of such technical and market uncertainty.

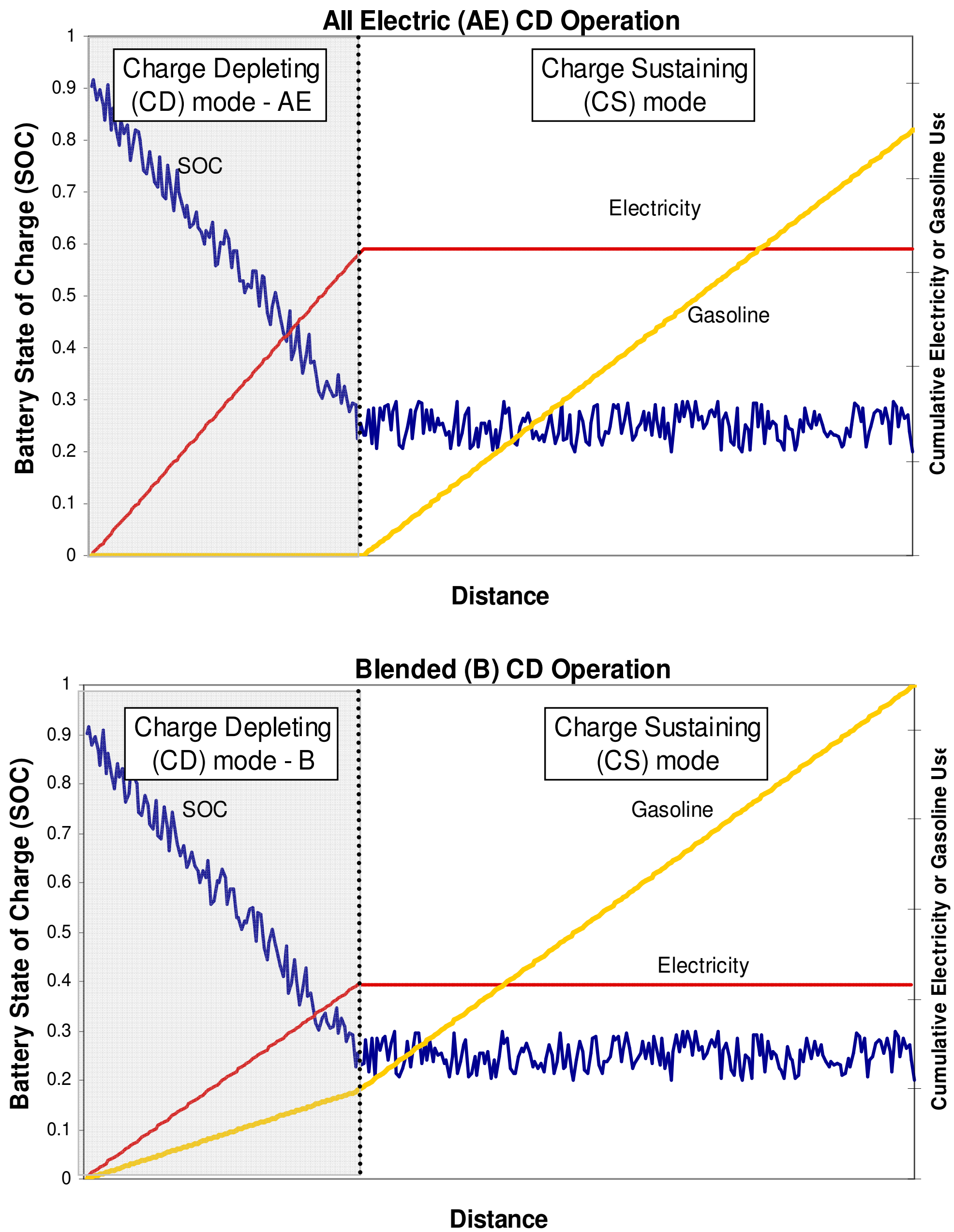
To help clarify issues relating to PHEV technology, here I briefly explain three fundamental PHEV concepts. First, for any given architecture, a PHEV can operate in one of two modes: *charge sustaining* (CS) or *charge depleting* (CD). Figure 3 (adapted from Kromer and Heywood, 2007, p31) illustrates these two modes in two different types of operation. In both graphs, the blue line and left-hand vertical axis represent the battery's state of charge (SOC), ranging from 0 percent to 100 percent, and the horizontal axis is the distance traveled.[3] In these examples, the battery is "fully" charged (from an electrical outlet) to 90 percent SOC at the beginning of the cycle. For a distance the charged PHEV is driven in CD mode—energy stored in the battery is used to power the vehicle, gradually depleting the battery's SOC. Once the battery is depleted to a minimum level, set at around 25 percent in this example, the vehicle switches to CS mode. In CS mode the SOC is sustained by relying primarily on the gasoline engine to drive the vehicle, using the battery and electric motor to increase the efficiency of the

[3] In practice, the maximum SOC may be limited to less than 100 percent, and the minimum SOC constrained to more than 0 percent, both to preserve battery life and improve safety. The difference between the maximum and minimum SOC is known as the usable depth of discharge (DOD), which varies across battery and vehicle designs.

gasoline engine, as is now done in an HEV. Small cycles can be seen in the SOC during CS mode (as in CD mode), where the battery takes on energy from the engine driven generator or from regenerative braking and uses the energy in the electric motor to improve the efficiency of engine operation. The vehicle remains in CS mode until the battery is plugged in again to recharge. The distance a fully charged PHEV can travel in CD mode before switching to CS mode is called *CD range*.

A second key PHEV concept is that a vehicle can be designed for *all-electric* (AE) or *blended* (B) operation in CD mode. A PHEV designed for AE operation can be driven for the CD range using only electricity from the battery, and the engine is not used at all. The top graph in Figure 3 illustrates an AE design. In contrast, a PHEV designed for B operation (the bottom graph in Figure 3) will use electricity and gasoline to power the vehicle during the CD range—energy from the engine and the battery are "blended" together through the drivetrain. CS driving can be identical for both PHEV types, where only gasoline is used to power the vehicle. Thus, if an AE and a B design are equivalent in every way other than CD type, cumulative gasoline (gold line) use will be higher in the B design for any vehicle trips that include a portion of CD driving, as indicated by the right-hand vertical axes in the figure. Also, a PHEV designed for AE driving will require a battery capable of delivering more power than a PHEV designed for B driving because the battery (and motor and power electronics) must be capable of providing the full power of the vehicle during CD mode, not just partial power.

Figure 3: Illustration of the discharge pattern of a PHEV battery (~65% depth of discharge)



Source: Adapted from Kromer and Heywood (2007, p31). Used with permission from authors.

Third, PHEV designs are commonly described according to CD range; the common notation is PHEV-X, where X is distance in miles. For instance, a PHEV-10 can be driven 10 miles in CD mode before switching to CS mode. However, this notation does not distinguish whether a PHEV in CD mode is operating all-electrically or using blending, nor does it specify the driving conditions that would allow CD mode for the stipulated distance. Comparisons of PHEVs, even those sharing the same PHEV-X designation, must reconcile assumptions regarding CD operation and driving behavior.

Kurani et al. (2009) discuss how further confusion in PHEV notation can result from differing concepts of PHEV-X. First, Gondor and Simpson (2007) argue that X should be defined as the equivalent number of miles of petroleum displaced by electricity from the battery. This approach makes no distinction between AE and B operation; a fully charged PHEV-10 could store and use enough electricity to reduce gasoline use by the amount of gasoline required to travel 10 miles, but not necessarily during the first 10 miles. On the other hand, the California Air Resources Board (2003) defines X as the total miles that can be driven before the gasoline engine turns on for the first time, also known as AE range (or zero-emissions range). By this definition, a fully charged PHEV-10 could be driven for the first 10 miles without using any petroleum. CARB’s definition requires a more powerful electric motor and battery to avoid engine use during CD mode, i.e., CARB assumes AE mode. Again, these distinctions must be clarified when discussing the battery requirements of a particular PHEV design. In this dissertation, I identify CD range and operation of a given design with the following notation: AE-X or B-X.

Given the wide variety of plausible PHEV designs, it is not easy to determine if battery technology is “ready” for PHEV applications. Research by Axsen et al. (2008; 2010) describe how differing assumptions about PHEV operation, range, body type and driving and recharge patterns can drastically influence the estimated technological requirements of battery technology. Further, battery development involves a careful tradeoff between five key attributes: energy capacity, power, cost, safety and longevity. Given the more aggressive technology goals of the U.S. Department of Energy (2007), the nickel-metal hydride (NiMH) battery chemistries used by today's HEVs will not likely be usable for PHEV applications. Instead, lithium-ion (Li-ion) chemistries will have to be developed, given their potential for higher energy and power density. However, as detailed further below, a recent consumer survey suggests that many potential PHEV buyers would be interested in buying less technologically advanced designs, e.g. a B-10, which could feasibly be built with battery technology that has already been commercialized (Axsen, et al., 2010).

A list of PHEV designs promised by automakers suggests that a variety of PHEV designs may be available for purchase within the next few years (Table 1). For illustration of the range of potential designs, compare the B-20 Prius in development by Toyota with the AE-40 Volt planned by General Motors. Also note that most PHEV concept vehicles are presented according to an AE range, even when their anticipated top electric speed (and power capabilities of the electric motor) is unlikely to cover the range of accelerations and speeds required for the driving behavior of typical U.S. drivers. For instance, I add the B-20 specification in brackets to the Toyota Plug-in because although Toyota typically describes the vehicles as AE-12, the vehicle performs more like a B-20 with "average use" (English, 2009). Of course, this list of forthcoming PHEV models is highly speculative, and the actual timing and specification of commercialized PHEVs may change dramatically—but it is a useful illustration of the automotive industry's present perceptions of the future of PHEVs.

Table 1: PHEV model and concepts planned for commercialization (presently publicly available)

Make	PHEV Model	Release Year	Design	Batt. Capacity	Top Electric Speed	Price
Toyota	Prius	2012	AE-12.5 (B-20)	~5 kWh	62 mph	~$48k
GM	Volt	2011	AE-40	16 kWh	>70 mph	~$40k
Volvo	V70	2012	AE-30	12 kWh	80 mph	??
Ford	Escape	2012	AE-30	10 kWh	??	??
Fisker	Karma	2010	AE-50	22 kWh	125 mph	~90k
VW	Golf	2010	AE-30	12 kWh	35 mph	??
Hyundai	Blue-Will	2012	AE-38	??	??	??

Sources:
Toyota: http://www.popularmechanics.com/automotive/new_cars/4339705.html
GM: http://www.popularmechanics.com/automotive/new_cars/4338192.html
Volvo: http://www.autotropolis.com/autotropolis-columns/car-tech/volvo-announces-plans-for-phev-by-2012.html
Ford: http://www.greencarcongress.com/2009/02/ford-selects-jo.html
Fisker: http://www.autotropolis.com/wiki/index.php?title=2010_Fisker_Karma
VW: http://www.allcarselectric.com/blog/1036439_behind-the-wheel-of-volkswagens-golf-twindrive-phev

1.3 Anticipating the early market for PHEVs

The plausible early market for PHEVs can be conceptualized according to consumer constraints, e.g. what proportion of car buyers currently have the ability to plug-in a vehicle at their home, and according to consumer interests, e.g. what proportion of those car buyers are interested in purchasing a PHEV, and if so, what kind of PHEV?

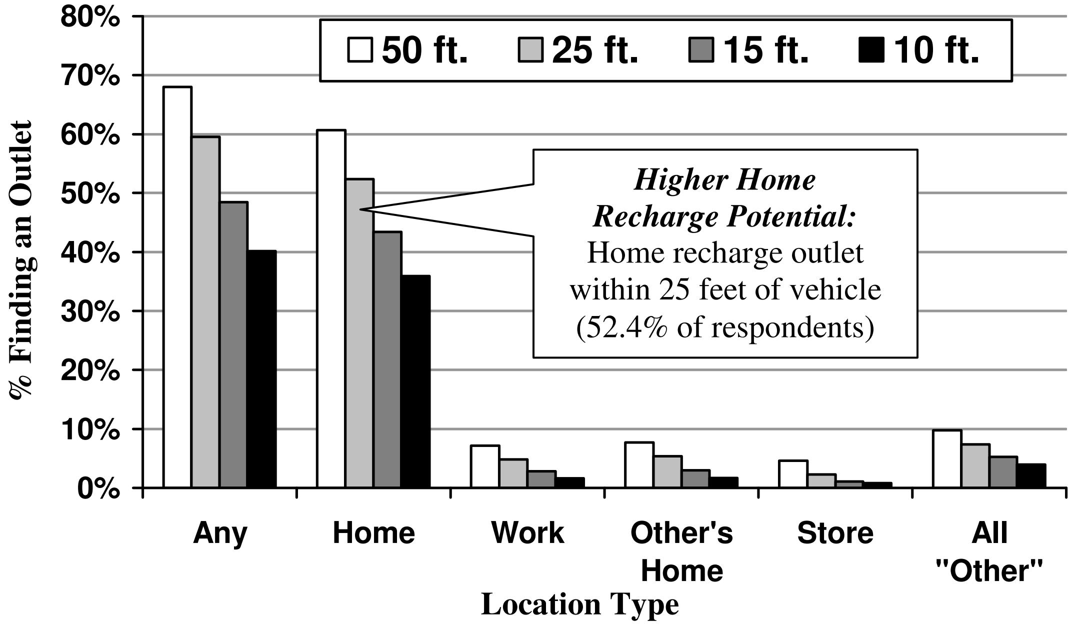
Several studies have explore consumer constraints, estimating the proportion of households with home recharge access to be 28 percent in the U.S. (Nesbitt, et al., 1992) and 15 to 30 percent in California (Williams and Kurani, 2006), while another study assumes that 86 percent of American drivers park within 25 feet of an electrical circuit

(Graham, et al., 2001). Due to lack of direct data, such previous market analyses have relied on assumptions about consumer behavior, which are typically drawn by proxy from databases of travel patterns and housing stocks.

A study by Axsen and Kurani (2008; 2009) sought to reduce some of these uncertainties for the plausible early U.S. PHEV market. Researchers designed a web-based survey which they administered to 2,373 new vehicle buying households in what they judged to be a fairly representative sample of such households in the U.S. The survey was implemented in three separate pieces, requiring multiple days for households to answer questions, conduct a review of their own driving and parking patterns, and then complete a sequence of PHEV design exercises. Recharge potential data were collected with a Plug-in Potential diary of driving and parking for one of the household's vehicle. PHEV design priority data were collected in with priority-evaluator games.

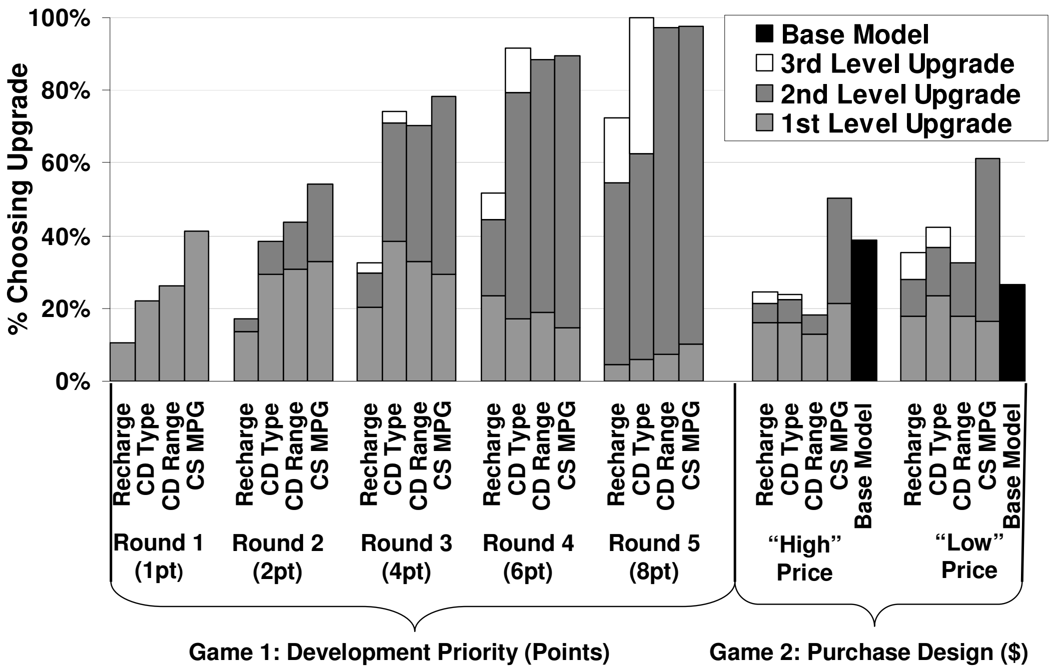
The authors conclude that just more than half the population of U.S. households that buy new cars have the potential to recharge a vehicle at home with at least 110-volt service (Figure 4). This proportion is one-and-a-half to three times larger than previous estimates. (One explanation for this difference is that previous studies looked at all households, not just new vehicle buyers.) Few respondents located non-home recharge opportunities, such as at their workplace, friend's and family's homes, restaurants, etc. Recharge potential, that is, the spatial-temporal correspondence between a parked vehicle and a 110-volt electrical outlet, was estimated to peak between 12am and 6am when most vehicles are parked at home, reaching a broad minimum from 10am to 4pm when most vehicles are parked at work or other locations or are being driven.

Figure 4: Access to recharge spot (110-volt) by location and outlet distance (all respondents, n = 2,373)



Given the distributions of car buyer's access to recharging and the interests in PHEV designs, Axsen and Kurani estimate that about one third of U.S. new vehicle buying households have both the required infrastructure and interest to purchase a vehicle with plug-in capabilities—a sub-sample they identify as the plausible early PHEV market respondents. Within this plausible early market, there is a wide diversity of consumer interests in PHEV design options (Figure 5). Starting with a base PHEV design offering 8 hour recharge times, B-10 capability, and a 10 mpg increase in CS mode over a conventional vehicle, the most popular upgrade category was improved CS fuel economy. Respondents also exhibited interest in increasing vehicle range in CD mode, and improving CD fuel economy (with more electricity and less gasoline to the "blend"). There was little evidence of inherent demand for AE-X vehicles, even following the one-day driving diary, the tutorial on electric-drive vehicles, and PHEV design games. This finding suggests that while AE-X designs may presently be attractive to a small subset of consumers, including those who are already knowledgeable and experienced with electric vehicles, at this point in time most households who buy new vehicles are more interested in high fuel economy.

Figure 5: Attribute selection in design exercises (plausible early market respondents, n = 827)

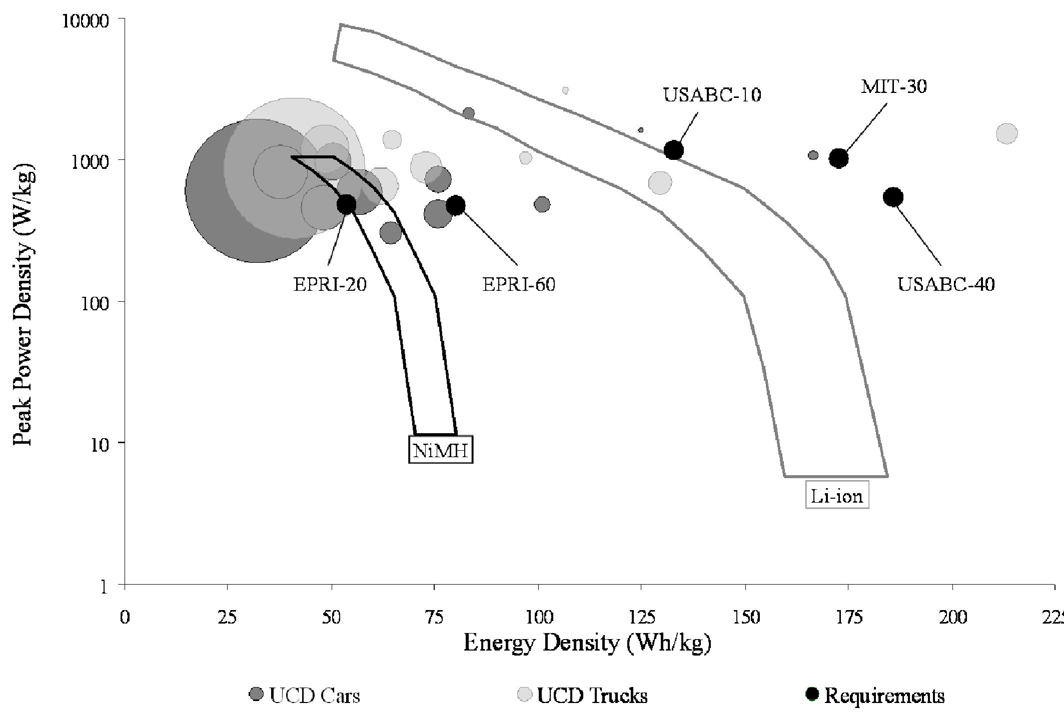


Also, about one-third of the plausible early market respondents who constructed a PHEV variant of their likely next new car (that they selected rather than a conventional version of that car) chose no upgrades above the proffered base PHEV design. Thus, there may be substantial potential for market success with less ambitious PHEV designs, i.e. B-10 vehicles, particularly with high CS fuel economy. This wide variety of PHEV design selections supports the notion of a “blank slate” early PHEV market, where early buyers may have little in the way of performance expectations—that is, expectations of what a PHEV is or should be.

Translating these consumer interests to battery requirements (Figure 6, from Axsen, et al., 2010) suggests that the vast majority of consumer-selected PHEV designs (grey circles) fall within the energy and power capabilities of an already-commercialized battery chemistry (NiMH), and also fall short of the PHEV technology goals (power density and energy density) espoused by experts from the U.S. Advanced Battery Consortium (USABC) (Pesaran, et al., 2007) and Massachusetts Institute of Technology (MIT) (Kromer and Heywood, 2007). In other words, while some expert goals for PHEV batteries call for advanced Li-ion battery technology or better, the PHEV design interests of the majority of plausible early market respondents in this nationwide study suggest that the cheaper battery technology currently proven in HEV applications (NiMH), or something like it, could be used to meet the needs of most early PHEV buyers—if they are given the opportunity to buy the PHEVs they say they want.

Overall, these analyses provide baseline measures of market potential—which could be highly subject to influence. Recharge infrastructure could expand to a higher percentage of households with changes in residential building and remodeling codes, as well as increased employer and publicly installed vehicle recharge outlets. Desired PHEV designs and capabilities may be even more subject to change. Survey respondents had little pre-existing understanding of PHEVs and the elicited responses could be sensitive to the PHEV information provided by researchers. As information about PHEV technology spreads throughout social groups and the economy, along with corresponding developments in PHEV values and meaning, interest in particular attributes could shift. For example, AE-X designs could become more meaningful to car buyers as they gain experience and as they participate in the process of identifying just what AE-X means to people—particularly as battery costs decline with increased manufacturing experience. But the baseline provided by this research does help illuminate near-term opportunities for PHEVs, as well as questions for further research, which I now consider for this dissertation.

Figure 6: Distribution of battery requirements for PHEV designs selected by potential early market respondents and USABC, MIT, and EPRI



Source: Chemistry Ragone plots from Kalhammer *et al.* (2007).
Notes: For UCD Cars and Trucks, the areas of the circles are proportional to the number of respondents who designed the PHEV from which those battery requirements flow. The circles indicating USABC's, MIT's, and EPRI's requirements are sized simply to make them perceptible.
The potential early market respondents plotted here account for 33 percent of the entire survey sample of U.S. new car buying households.

1.4 How might consumers value PHEVs?

1.4.1 How is a PHEV an innovation?

While the studies noted above help depict the distribution of recharge constraints and design interests of the plausible early PHEV market, it is also important to understand the perceptions and motives of these potential buyers. In other words, which attributes of the technology are perceived as important benefits by vehicle buyers? This question is particularly challenging when focusing on a new technology, which, from a technological perspective, is often described as an *innovation*. Classifying the technology as an innovation requires further clarification about what is being replaced by the innovation, if anything, and how "disruptive" the innovation might be for the current market. However, here I caution against following a purely technological perspective. Such an approach focuses on the functional attributes of electric-drive vehicles: the drivetrain that dictates engine performance, driving range and potential for fuel savings. These attributes would be compared to the conventional gasoline engine drivetrain that could be replaced. The transition required for consumers to adopt the innovation is sometimes described on a continuum of continuity, concerning the degree of change in the physical product itself, its performance or its price (Ehrnberg, 1995). Robertson (1971) provides a commonly cited classification: a *continuous* innovation involves only a slight modification to an existing product, and a *discontinuous* innovation is a previously unknown product that requires drastic behavior changes. From this perspective, the more continuous an innovation is, the more easily it can diffuse and attain market success.

From this technological perspective, one might speculate that, for consumers, an HEV is a relatively continuous innovation; there is only a slight modification to the conventional gasoline vehicle that does not require change in consumption behavior, such as driving or refueling. In contrast, an EV is relatively discontinuous, requiring a drastic shift in refueling behavior—where the gas pump is completely replaced with an electrical outlet—as well as some degree of training and adaptation in driving patterns to make use of a presently limited refueling infrastructure. It is thus tempting to explain the different adoption rates of each technology based on functional continuity: as a relatively continuous innovation, the HEV has achieved significant market success; as a relatively discontinuous innovation, the EV has not. A purely technological approach also encourages researchers to focus on the incremental cost savings provided by electric-drive vehicles, such as by calculating payback periods and discount rates that are assumed to represent consumer perceptions regarding an HEV purchase.

However, a pure technological focus misses important issues, illustrated by Adamson's (2003, p772) alternative conceptualization of discontinuity as describing "products that, through the use of new technologies, create within the user group a paradigm shift in beliefs, attitudes and use." This consideration of beliefs and attitudes is an essential addition: what matters is how any technological or functional change is perceived by consumers. In this dissertation I do away with the notion of continuity, and instead provide a conceptualization of which attributes may be important for consumers considering an electric-drive vehicle—according to two dimensions in Table 2: functional/symbolic and private/societal.

Table 2: Conceptualization of PHEV attributes (hypothetical examples)

	Functional	Symbolic
Private	• Save money • Reliable • Fun to drive (experiential)	• Expression of self-identity • Convey personal status to others • Attain group membership
Societal	• Reduce air pollution • Reduce global warming • Reduce oil use	• Inspire other consumers • Send message to automakers, government, oil companies

1.4.2 The functional/symbolic dimension: What does it do and represent?

The first dimension, functional/symbolic, is related to Hirschman's (1981) categorization of innovations based on which type of attribute is perceived as novel by consumers: technology or symbolism. To Hirschman, technology innovations are tangible and functional, including the new services provided by the physical nature of the innovation, such as a fuel savings for HEVs. In contrast, symbolic innovations are intangible, where the innovation "communicates a different social meaning than it did previously", such as "sexiness, conservatism, and prestige" (Hirschman, 1981, p537). Hirschman (1981) presents a simple classification for innovations according to these dimensions, categorizing automobiles generally as both "high technology" and "high symbolism". In regards to adoption behavior and the diffusion (further explained in Chapter 2) of the technology through a social system, Hirschman (1981, p537) highlights the importance of carefully considering the symbolic dimension, where symbolic innovations may "possess fundamentally different properties and diffuse according to fundamentally different principles" relative to functional innovations. For an innovation scoring high on both dimensions, symbolism may present a sort of "secondary diffusion for it among those identifying with a relevant reference group" (p537).

Demand for motor vehicles is known to be associated with intangible, symbolic motives—often more so than functional motives (e.g. Steg, 2005; Steg, et al., 2001). In describing the history of automobile use in America, Gartman (2004) illustrates how intangible motives were dominant from the very introduction of automobiles in the late 19^{th} century. Vehicles were "used not for practical purpose but for leisure activities and public ostentation…the automobile quickly became defined in American culture as an instrument of freedom and leisure, and a symbol of wealth" (Gartman, 2004, p171). Following the development of the automobile to the present day, Gartman (2004, p187) describes the latest era of automobiles as one of "subcultural difference," where the desire of consumers to distinguish themselves continues to prevail, stimulating the emergence of new vehicle classes that demonstrate a distinct "lifestyle choice," such as SUVs, minivans, and according to Gartman, HEVs.

Focusing on HEVs, Heffner et al. (2007) conducted dozens of household interviews of HEV owners, finding that symbolism played an important role in every buyer's purchase decision. The authors classify five common symbolic meanings: "preserve the environment," "oppose war," "manage personal finances," "reduce support to oil producers," and "embrace new technology." Further, among individual households, these broader symbols were linked to more personal meanings, such as ethics, national independence and individuality. The authors found that the "HEV purchases were about constructing and communicating" the buyers' self identity "through a widely recognized environmental symbol" (Heffner, et al., 2007, p412). Thus, it is important to consider both functional and symbolic perceptions of electric-drive vehicles. In Table 2, *function* denotes attributes of functional or instrumental importance, including the basic services of accessibility and mobility provided by an automobile, or the incremental fuel savings provided by HEVs and PHEVs; the *symbolic* dimension includes the less tangible attributes of the vehicle, such as the owner's desire to express a certain value.

1.4.3 The private/societal dimension: Who is it good for?

The second dimension in Table 2, private/societal, provides a clear distinction between electric-drive and ICE vehicles. Green (1992, p133) describes a *private* good as being characterized by "exclusive and personal consumption and individual payment; not associated with the public welfare." On the other hand, a public (or *pro-societal*) good is characterized by "nonexclusive consumption and collective payment" such as "clean air" and "saving endangered species." Canzler (1999, p25) asserts that motor vehicles are perceived as primarily private goods, dating back to the original "race-travel-limousine" vision, where increasing demand was driven by goals of luxury and prestigious racing. However, electric-drive vehicles may present a divergence from the private good vision, having the potential to produce pro-societal benefits, such as contributing to reductions in air pollution, greenhouse gas emissions and foreign oil dependence. Thus, HEVs and similar vehicles can be associated with public welfare. The addition of these societal attributes leads Brown (2001) to classify the EV as a *mixed good*, that is, with aspects of a private and societal good. I extend this classification to HEVs and PHEVs.

The possibility of significant pro-societal attributes indicates that electric drive and other alternative propulsion vehicles may together produce a deviation from the purely private connotation of the conventional ICE. In essence, the emergence of electric-drive vehicles is not just an extension to the race-travel-limousine concept of a private good with functional and symbolic attributes, but in some cases could represent a new vision of motor vehicles I call the pro-societal car. The pro-societal car includes any vehicle technology that potential adopters can associate with public benefits; such technologies include hydrogen fuel cell, ethanol, and biodiesel vehicles. The word *pro-societal* represents all societal benefits, including environmental benefits, but also concerns of foreign oil dependence, or a desire to send pro-societal messages to government, oil companies, automakers or other drivers.[4]

1.4.4 Attribute dynamics: How might perceptions change?

To understand patterns of adoption and diffusion of an innovation over a particular time frame, one must account for dynamics in consumer perceptions of relevant functional, symbolic and societal attributes. For emerging technologies like electric-drive vehicles, significant shifts in all four boxes of Table 2 can be expected. First, functional attributes

[4] I also consciously chose the term "pro-societal" rather than "pro-social" for this dissertation to avoid confusion with the other meaning of social, i.e., *interpersonal*. This dissertation's primary emphasis is the exploration of social influence and social networks in this sense of interpersonal exchange rather than non-excludability. Throughout this dissertation, "social" is thus reserved as a synonym for interpersonal.

change with advances in battery and electric drivetrain technology. For HEVs, what may not be clear in Figure 1 is that the physical nature and variety of the “hybrid” has changed between 1999 and 2009; available vehicle models have increased from one to 19, including increases in the variety of body styles, degree of hybridization, achievable fuel economy, and range of purchase price.

Symbolic meanings are also dynamic. After teasing out several common meanings of HEVs, Heffner et al. (2007, p412) suggest that “as HEVs persist in the marketplace and as the variety of models expands, established meanings will evolve and new meanings will be added…new buyers may be motivated by novel meanings that were not recognized by earlier buyers.” As will be explored in Chapter 2, within and among social groups the creation of new symbolic meanings is a process of negotiation and renegotiation among many parties.

Third, perceptions of pro-societal benefits can be similarly dynamic and negotiable (Smith, 2005). Hess (2007) outlines an ongoing dispute over what constitutes a “clean bus” among U.S. cities. He demonstrates how fleet purchase decisions between compressed natural gas and emissions-controlled diesel vary with continual shifts and advances in technology (including hybridization), health research on the effects of air pollutants, emissions data, government regulation, and mobilization by activists and other public-interest groups. Similarly, Calef and Goble (2007) describe the controversy over the societal benefits of EVs during California’s ZEV mandate in the 1990s, where industry and pro-environmental interest groups battled to influence the state’s perception of the societal benefits of EVs. In another example, Calef and Goble (2007) illustrate how the EV movement in France was not supported by environmental groups due to a different priority: protesting the nuclear power plants that are used to generate electricity. What may be defined as "clean" at one moment or in one context is subject to change—and not just for brand new technologies. In 2007 for example, when HEVs had been commercially available in the U.S. market for nine years, a marketing firm released a report stating that from a lifecycle perspective of energy use, the Toyota Prius performed significantly worse than several SUVs, including the Hummer (CNW, 2007). Despite the many methodological flaws of that study, its findings were propagated in the media and are said to have since "distorted the debate" (Gleick, 2007, p1), planting doubt in the minds of some potential HEV buyers. In summary, the perceived societal attributes of emerging technologies, like functional and symbolic attributes, are subject to change and negotiation.

1.5 Why focus on the role of interpersonal influence?

Because humans are social beings, perceptions of functional, symbolic and pro-societal attributes as well as purchase decisions are firmly embedded in social processes. Yet only very recently have transportation researchers begun to explore the role of social interactions in individual transportation decisions (Carrasco, et al., 2008; Paez and Scott, 2007). As explained by Heffner (2007) and summarized in the next chapter, the dominant research approach in vehicle purchase behavior is based on the rational actor model of *discrete choice*—representing the consumer as an actor that chooses among available alternatives to maximize individual utility. Recent studies have attempted to include factors of interpersonal influence in such models for alternative fuel vehicles, but still rely on aggregated representations of behavioral dynamics, and ultimately yield little insight into the true role of social interactions in vehicle purchase behavior. In this dissertation, I employ a qualitative research design to explore such social processes in-depth—to yield new empirical and theoretical insights and to help guide future research efforts.

Responses to the survey described in Section 1.3 suggests the majority of new vehicle buyers have little or no familiarity with the idea of a PHEV, and may erroneously believe that existing HEVs can perform the same basic function as a PHEV, i.e., have the ability to be refueled by gasoline and to be plugged into an electrical outlet (Axsen and Kurani, 2008). This lack of awareness and understanding is both a constraint and opportunity. As a market constraint, unaware consumers may simply fail to recognize or identify compelling benefits of owning and operating a PHEV. On the other hand, the early PHEV market in the U.S. may be viewed as a blank slate, with little preexisting understanding of what a PHEV is or expectations of what it should be. Thus, the early actions of consumers, automakers, governments, electric utilities and other stakeholders could play an important role in establishing perceptions in the market. Similarly, the first commercially available PHEV incarnations could set a standard for consumer understanding and set expectations for functional, symbolic and pro-societal benefits. In this dissertation, I seek to observe how such perceptions are established by consumers in an interpersonal setting.

1.6 Summary and Scope of This Dissertation

This chapter introduced PHEVs as one type of electric-drive vehicle which includes a wide variety of design and use possibilities. The purchase and operation of such a vehicle might be classified under the broad umbrella of sustainable consumption practices—at least more so than the use of conventional vehicles from a GHG emissions or gasoline use perspective. Research suggests that about one half of U.S. new vehicle buyers are currently able to plug-in such a vehicle at their home and two-thirds of those are also interested in buying one. However, the market for such a technology will be strongly determined by the types of benefits it can offer to consumers—including functional, symbolic and pro-societal benefits—and how perceptions of such benefits develop as commercialization begins. This dissertation explores the role of interpersonal influence in the formation of stabilization of such perception, considering three main research questions.

1. Does interpersonal influence play a significant role in the adoption of electric drive vehicles?
2. If so, how can we characterize the interpersonal processes that impact consumer perceptions of functional, symbolic and pro-societal attributes?
3. Under what social conditions might households adopt electric drive vehicles and the pro-societal car? (And how might policy create those social conditions?)

The remainder of this dissertation is organized as follows:

- Chapter 2 surveys and compares literature and perspectives that link interpersonal influence to adoption behavior;
- Chapter 3 explains the qualitative research methodology I employed to observe the role of interpersonal influence within a PHEV demonstration project at the University of California, Davis;
- Chapter 4 depicts key empirical results from this methodology, seeking to address the first question above;
- Chapter 5 applies the five theoretical perspectives outlined in Chapter 2 to the research results in efforts to answer the second question;
- Chapter 6 addresses the third question by focusing on the stories of four households that demonstrate changes in motivations;
- Chapter 7 returns to the theories of interpersonal influence to suggest an integrated theoretical framework for future research; and
- Chapter 8 summarizes and concludes with policy considerations and suggested directions for further research.

2 Consumer Behavior and Interpersonal Influence

As explained in the previous chapter, the question of how and why consumers buy new products is central to the successful deployment of alternatively fueled and propelled vehicles. Because human behavior is complex, researchers in various behavioral fields, including sociology, anthropology, psychology and economics, often rely on models as simplifications of behavior. Some models are based on elaborate theories, and others are based on simple assumptions. In this chapter, I first review a general framework of behavioral models relating to *sustainable consumption*, then focus in more depth on five behavioral perspectives relating to the subject of this dissertation: the role of interpersonal influence.[5] These five perspectives help to guide analysis in later chapters: Chapter 3 describes the research methodology developed to explore these perspectives in an empirical study; Chapter 5 applies each perspective to observed case studies and assesses their validity; and Chapter 7 proposes an integrated theoretical approach based on elements of these perspectives that proved useful in empirical application.

---

[5] In section 1.4 I noted the inherent uncertainty in defining the purchase or use of a PHEV as pro-societal or sustainable. From here on, in using terms like "sustainable consumption" and "pro-societal practices," I offer the same qualification as Jackson (2005, p1):

> *"…assessing the environmental impacts of specific behaviors or intentions is beyond the scope of this document. It will concentrate instead on people's pro-environmental attitudes and intentions and the relation between these and their behaviors."*

In other words, I consider behavior to be sustainable or pro-societal if it may be perceived as such by the consumer—leaving estimates of actual societal impacts to other research.

2.1 Models of sustainable consumption

Jackson (2005) identifies five broad categories of consumer behavior model, which I depict in Table 3 according to two main factors: i) the assumed degree of the individual's cognitive deliberation and ii) accounting for individual versus social (interpersonal) motives. His first category is *expectancy-value models*, where behavior is the result of individual choices which are "supposed to be made on the basis of the expected outcome from the choice and the value of those outcomes" (p.viii). This category includes the *rational choice model*, where an individual consumer is assumed to calculate the costs and benefits resulting from several alternate courses of action, then chose the action which maximizes their expected net benefit. Jacksons summarize three main assumptions of the rational choice model (p. vii):

1. "individual self-interest is the appropriate framework for understanding human behavior,"
2. "rational behavior is the result of processes of cognitive deliberation,"
3. "consumer preferences are exogenous to the model…they are taken as given without further elaboration as to their origins or antecedents."

Table 3: Models of consumer behavior, adapted from Jackson (2005)

Category	Example	Deliberative	Unit of Analysis: Individual-Social
Expectancy-value	Rational choice	Always	Individual
Adjusted expectancy-value	Theory of planned behavior	Always	Mostly individual
Normative	Value-belief-norm	Always	Mostly individual
Habit	Heuristic models	Sometimes	Individual
Sociality	Symbolic interactionism, structuration	Sometimes	Mostly social

Take the simple example of a man purchasing an HEV, say a Toyota Prius. Following a rational choice model, I might represent this man as having chosen the Prius from a set of available alternatives, which included the Prius, a Toyota Corolla and Honda Civic. I would assume that prior to making his choice the man had calculated his expected value from each possible outcome, that is, the value to him of purchasing each vehicle. I might represent his expected value as a function of several attributes of each vehicle, such as the purchase price, the net present value of future fuel costs, horsepower and interior space—each of which is weighted according to his set preferences. Through this process of rational deliberation, the man chooses the vehicle which maximizes his own net-benefit, in this case observed as the Prius. Perhaps he made his choice because his expected fuel savings offset the Prius' added purchase price, while horsepower and interior space were not sufficiently different among the models in his choice set.

Jackson (2005) outlines several common criticisms of expectancy-value and rational choice models. Such models neglect that human beings have cognitive limitations, both in lack of access to information, e.g., future fuel prices, and an inability to rationally process complex information, e.g. calculating net present value of future fuel expenditures, and integrate this information into a metric of net benefit. Humans often rely on heuristics, habits and emotions in decisions making—if a decision is made at all. Further, such models' exclusive focus on self-interest neglects the potential for social, moral or altruistic motivations. Each of the next four categories of behavioral model attempts to address one or more of these criticisms.

Adjusted expectancy-value models attempt to "go beyond assumptions of rational choice and unravel the psychological antecedents of consumer preferences" (Jackson, 2005, p.viii). One example is the *Theory of Reasoned Action* (Ajzen and Fishbein, 1980) which represents two antecedents to behavioral intention: i) an individual's attitude towards the behavior (based on belief and evaluation of the outcome), and ii) their subjective norm regarding the behavior, defined as the individual's "perception that most people who are important to him think he should or should not perform the behavior in question" (Ajzen and Fishbein, 1980, p57) . Relating back to the Prius buyer example above, the Theory of Reasoned Action would see the purchase decision as flowing in part from the buyer's attitude towards the purchase, based on his beliefs and evaluations of outcomes, which again could be based on purchase price, fuel savings, horsepower, and interior space. But this behavioral model also represents the buyer as considering whether his friends and family think he should have bought the Prius, which adds a social motive to his behavioral intention. However, as in the first category, most adjusted expectancy-value models assume that decision making is a deliberative process, typically ignoring affective motivations and habits, as well as the formation of attitudes.

Jackson's third model category focuses on moral and *normative* factors, exploring the roles of an individual's values concerning the environment, e.g. ecological value theory, or moral obligation to "engage in pro-social behavior" (p.53). An example is Stern et al.'s (1999) *Value-Belief-Norm theory*, which postulates that if an individual holds relatively strong altruistic or biosphereric values, and weak egoistic values, they are more likely to accept the New Environmental Paradigm, and thus "develop a personal norm to engage in pro-environmental actions" (Jackson, 2005, p57). Thus, the Prius buyer may have considered himself to be a charitable, selfless environmentalist, and views his transportation choices as having environmental consequences that he is responsible for, so he develops a personal norm to purchase and drive HEVs—if he considers such an action to be pro-environmental. However, Stern et al.'s model does little to explain how such altruistic, biospheric and egoistic values develop in the first place.

The fourth category departs from the deliberative assumptions of the previous categories, considering the roles of *habits* and simplifications in a world of limited cognitive resources (Jackson, 2005). Examples include models of *heuristics*, where individuals use cognitive shortcuts, that is, they "employ various approximation methods that enable them to process the relevant information in making a decision" (Tversky, 1969, p46) such as "elimination by aspects" (Tversky, 1972), where an individual removes available alternatives from the choice set based on certain attributes. If the Prius buyer was uncertain how to compare the three vehicles with similar sizes and difficult cost calculations, he may have relied on a heuristic: simply eliminating all non-hybrid options, or all vehicles that weren't available in blue. Further, individual responses can be influenced by the framing of the decision (Tversky and Kahneman, 1974)—the same Prius buyer might have chosen differently if he was comparing the Prius with two motorcycles, two other HEVs, or two luxury vehicles. The role of habit could also come into play if the buyer was used to buying whatever sedan had the best fuel economy, for example

Jackson's final behavioral model category, *sociality*, moves beyond the individual as the sole unit of analysis and attempts to account for the "socially embeddedness of environmentally significant behavior" (2005, p ix). An example is Blumers' (1969) work in *symbolic-interactionism*, which Jackson (2005, p71) summarizes according to three key premises:

1. "human beings act towards things on the basis of the symbolic meanings those things have for them"
2. "the meaning of such things is negotiated through social interaction"
3. "in any given situation these meanings are handled in and modified by an 'interpretative process' specific to the situation and the individuals involved."

Thus, as noted in Section 1.4 of the previous chapter, a new technology can have symbolic as well as functional value, and these symbolic values are negotiated through social processes, where meanings can change and develop in different social contexts. The Prius buyer may have associated the HEV with a positive symbol of "environmental responsibility" as well as a negative symbol of "tree-hugging hippy." He may have consulted and observed his friends and family to learn which symbols they recognize, and learned that the Prius would win him status among his outdoors friends, but earn snickers among his coworkers. His purchase of the Prius and the social interactions that result serve to further develop the symbolic meaning of the vehicle among his social groups. Such a behavioral approach thus views sustainable consumption as occurring and developing within a broader social arena.

Looking across his model categories, Jackson (2005, p89) highlights the importance of “integrative theories of consumer behavior” which attempt to encompass numerous dimensions. An example is Giddens’ (1984) *structuration theory*, which concerns “the relationship between agency (or human action) and structure (the social institutions that constitute the framework for human action)” (Jackson, 2005, p89). Structuration attempts to account for behavioral processes at the individual level, e.g. the Prius buyers desire to own a new vehicle technology, as well as the social context, e.g. the support or rejection he may experience in his social group, and the interactions between them, e.g. how his purchase may help to normalize HEV ownership in his group. Taking all reviewed categories of behavioral models into consideration, Jackson (2005, p.x) suggests that “a useful model has to account for: motivations, attitudes and values; contextual or situational factors; social influence; personal capabilities; and habits.” I will return to this suggestion in Chapter 7 when I seek to construct an integrative model of interpersonal influence. Next I consider the use of behavioral models in the present application of pro-societal vehicle purchase behavior.

2.2 Applications to vehicle purchase behavior

As explained by Heffner (2007), the dominant behavioral model employed in research on vehicle purchase behavior is the rational actor model of discrete choice—representing the consumer as an actor that chooses among perceived available alternatives to maximize their individual utility. Train (1980) constructed one of the earliest vehicle choice models to include alternative fuel technologies (electric vehicles, PHEVs—then called hybrids, hydrogen and aluminum-air). The model specified vehicle attributes for each vehicle option, including purchase price, operating cost, weight and performance, as well as the demographic characteristics of the car buyer, and forecasted market shares of the different alternative-fuels. Later models were built based on similar function-based attributes, often using hypothetical consumer choice data (stated preferences) to estimate model coefficients (e.g. Brownstone, et al., 2000; Bunch, et al., 1993; Calfee, 1985; Potoglou and Kanaroglou, 2007) or using actual market data (revealed preferences) (e.g. Wall, 1996). Some rational choice models have attempted to include less conventional explanatory factors, such as Ewing and Sarigollu's (2000) specification of attitudinal variables regarding technology, the environment and locus of control. However, these alterations still maintain the deliberative, individual-centric assumptions of expectancy-value models. Because such models focus on the functional aspects of alternative-fuel technology, their conclusions generally focus on the functional drawbacks relative to conventional vehicles, such as increased purchase price, reduced storage space due to batteries or fuel tank, limited range due to batteries, and increased refueling or recharging time.

Similar to Jackson's broader criticisms of rational choice, some transportation researchers argue against the almost exclusive use of this method to study new markets for vehicle technology. Turrentine et al. (1992) discovered that many consumers had little familiarity with electric vehicles or other alternative fuel technologies, and their so-called preferences were non-existent or instable. Instead, consumers created and developed their preferences with exposure to and discussion of the technology in question. These researchers branched away from the rational choice framework, instead using an "interactive stated lifestyle-preference" techniques to simulate "decision making contexts designed from actual behavior of the household" and allowing for education and learning process as part of the choice process (Kurani, et al., 1994, p247). They later adapted these techniques to a large-scale survey sample (Kurani, et al., 1996; Turrentine and Kurani, 1998). By providing more extensive information to participants and creating realistic decision making contexts, this line of research produced significantly different conclusions than relatively simplistic rational choice studies—demonstrating how households could adapt their lifestyles to new, limited-range vehicle technologies. However, even this research assumed a largely deliberative model of consumer behavior, and though decisions were observed at the household level (as opposed to individual completion of questionnaires), researchers did not account for the larger social context of transportation decision making.

Only very recently have transportation researchers begun to explore the role of social interactions in individual transportation decisions (e.g. Carrasco, et al., 2008; Paez and Scott, 2007). Specific to alternative fuel vehicles, several studies have attempted to introduce social factors to rational choice models, through the empirical estimation and inclusion of parameters representing aggregated preference changes as a result of increasing technology market share (Axsen, et al., 2009; Mau, et al., 2008), word-of mouth effects (Struben and Sterman, 2008), and information search channels (van Rijnsoever, et al., 2009). However, these approaches rely on aggregated representations of behavioral dynamics loosely connected to empirical findings from diffusion research in other disciplines (discussed next) and ultimately yield little insight into the role of social interactions in vehicle purchase behavior. To better understand interpersonal influence within the context of new vehicle sales, I now turn to a literature review of different perspectives of interpersonal influence from a variety of disciplines and applications.

2.3 Perspectives of interpersonal influence and adoption

Readers should note that interpersonal influence literature is confused by a myriad of inconsistently used terminology. Manski (2000) explains how social interaction researchers will typically "borrow jargon from sociology or social psychology" (p117) and refer to loosely defined, sometimes interchangeable, concepts like "'social norms,' 'peer influences,' 'neighborhood effects,' 'conformity,' 'imitation,' 'contagion,' 'epidemics,' 'bandwagons,' or 'herd behavior'" (p127). He argues that this "abundance of concepts" (p121) arises in part from the imprecise use of verbal reasoning rather than formal, mathematical analysis of such. In this section I agree with Manski that in efforts to explore social influence, "the very first step must be to get the concepts right" (p132).

However, in this review of different research perspectives, I still must rely on verbal reasoning—reviewed concepts are far too complex, uncertain and amorphous to be easily or appropriately quantified at this stage, if ever.

One research perspective has provided the dominant conceptualization of new product adoption: the *diffusion of innovations* (DOI). DOI emphasizes the role of information diffusing from *innovators* and *early adopters* to the remaining majority via interpersonal communication. The DOI approach has several strengths which have warranted its application and development in a wide array of disciplines, perhaps the greatest strength being a simple language to facilitate sharing and learning across disciplines. However, I argue that DOI has very important weaknesses which are particularly exacerbated when applied to the adoption of technologies and ideas with both functional and symbolic—and pro-societal, in particular—costs and benefits. Electric-drive vehicles are an example of such complex innovations. I argue that electric-drive vehicles, as well as other alternatively fueled vehicles, should be studied under a broader category of innovation, which I call the *pro-societal car*.

In this section, I illustrate the strengths and weaknesses of DOI as one application of the *contagion* perspective, which focuses on the role of information flow, then discuss four alternative perspectives: *conformity*, which focuses on individual thresholds and motivations to mimic others; *dissemination* as the intentional diffusion of information by a core group or critical mass; *translation* as the tendency for various relevant social groups to steer the path of technological development and negotiate interpretations; and *reflexivity*, which explains the motivations of individuals seeking to establish lifestyle practices consistent with their self concept. I warn the reader that my summary of these five perspectives is actually a simplification of dozens of complex research approaches and theories. My intent is to present these five perspectives as an approachable synthesis of other literature. I explain each perspective in as general terms as possible—typically more general than the original authors intended—e.g. contagion, then focus on particular approaches, e.g. DOI. Further, these perspectives are not necessarily exhaustive or mutually exclusive. In fact, social network analysts often blend elements of contagion and conformity.

In Section 1.4, I explained that electric drive vehicles and other pro-societal cars are complex innovations. In addition to functional attributes, symbolic and societal attributes are highly relevant. Upon surveying literature in various disciplines, it is clear that research is muddled with varying and often confused terminology. A relatively neutral set of questions helps to clarify such confusion. Following a similar framework to that employed by Bruun and Hukkinen (2003), I present five questions to ask of each perspective on interpersonal influence and adoption:

1. What is the innovation, and what attributes are important?
2. What are the system boundaries?
3. Who adopts earlier, and why?
4. Who adopts later, and why?
5. What drives adoption from earlier to later adopters?

The first question addresses the *object* of analysis. Terms range widely, including innovation, invention, new product, novelty, technology, practice, artifact, trait, symbol, meaning and interpretation. While slight variations in terminology are trivial, differences in concept are crucial; of particular importance is how the concept addresses (or fails to address) the four attribute categories presented in Table 2. The second question concerns the boundaries of the *system* in which the innovation is being adopted, where terminology includes the market, social system, social group, social network, or lifestyle sector. System boundaries frame the analysis, determining who and what can play a role in the adoption process, as well as the nature of relationships among these components. The third and fourth questions address the fundamental concepts of *adoption patterns*: do earlier adopters differ from later adopters in any important way other than timing of adoption, and if so, how? Earlier adopters can be labeled innovators, inventors, instigators, visionaries or organizers. Terminology for later adopters includes imitators, the early and late majority, laggards, conformists, social learners, and followers. The fifth question addresses the process of interpersonal interaction that ultimately drives adoption, which also determines the name of each approach: contagion, conformity, dissemination, translation and reflexivity. A summary of these approaches and questions is presented at the end of the section in Table 4.

2.3.1 Contagion: Interpersonal communication

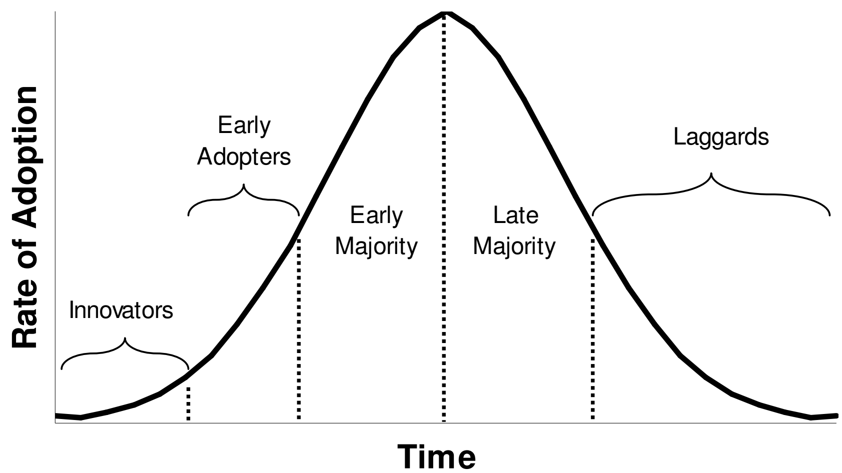
The *contagion* perspective focuses on social influence as the flow of information among individuals. The term is borrowed from epidemiological studies of how diseases are spread through a population. Contagion can alternatively be called *diffusion*, a term borrowed from physics that refers to the movements of a substance from higher to lower concentration areas. While this perspective can apply to any social influence approach that focuses on information flow, here I focus on DOI and social network analysis as prevalent examples.

Diffusion of innovations (DOI)

In the DOI approach, adoption is primarily driven by *diffusion*, "the process in which an innovation is communicated through certain channels over time among the members of a social system…a special type of communication, in that the messages are concerned with new ideas" (Rogers, 2003, p5). The object of focus is the *innovation*, "an idea, practice or object that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p12). The likelihood of an innovation to successfully diffuse is hypothesized to depend on five main characteristics: 1) relative advantage over the object it replaces, 2) compatibility with existing values, experiences and needs, 3) complexity, 4) trialability, and 5) observability of outcomes (Rogers, 2003). Thus, an innovation is more likely to be adopted if: it demonstrates advantage over previous technologies and competing alternatives, it fits in with the current culture, it is not too complex for new users to figure out, it can be tested before adoption and visible success can be demonstrated by previous adopters.

The setting of the diffusion process is the *social system*, "a set of interrelated units that are engaged in joint problem solving to accomplish a common goal" (Rogers, 2003, p23). Moore's (1999) more business-oriented definition is that of a market, consisting of potential customers with similar needs whom reference each other. This system of potential adopters is divided into *adopter categories*, based on the empirical observation of adoption rates following a bell-curve over time (Figure 7).

Figure 7: DOI adopter categories



Source: adapted from Rogers (2003)

The first to adopt are the *innovators*, a sub-group characterized as obsessively venturesome, progressive, cosmopolite individuals, usually with a love of technology, and above average education and socioeconomic status (Rogers, 2003). Next are the *early adopters* who are characterized as visionaries who use extensive social networks to spread information about the innovation to the masses. Following are the *early majority*, *late majority* and finally the *laggards*. Each category is characterized as having slightly different motivations for adoption, where earlier adopters are more interested in the functions of the innovations, and resistant later adopters are eventually influenced by peer pressure and economic necessity. Bass (1969) provides an even simpler classification of adopters with only two categories: innovators that are completely independent of others in their purchase decision, and imitators that are influenced by innovators and other imitators. In either variation, placement in adopter categories is determined by *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, p280).

In DOI, the adoption process is hypothesized to be driven by communication, including word-of-mouth and mass media. Rogers (2003) classifies two types of information: 1) *knowledge*, which includes basic awareness of the innovation's existence, how it can be used, and potentially its underlying principles, and 2) *persuasion*, which the persuaded individual uses to form attitudes about the overall value of adoption. Both types of information are thought to flow from individuals in the innovator category to those in later adopter categories, with early adopters playing a particularly important role as the gatekeepers between technology loving innovators and the majority. Moore (1999) provides a frequently-cited revision to DOI, asserting that there is a substantial divide between Roger's early adopter and early majority categories. This *chasm* results from a communication gap between individuals in these two categories, who don't normally communicate with one another. Moore claims that aggressively crossing this chasm is the most important challenge for any new product.

Under DOI, the adoption of an electric-drive vehicle, say an HEV, would primarily be explored from a technological, functional focus—as a new technical device. The targeted social system is the entire new automobile market, perhaps limited to buyers of vehicle body styles in which an HEV is available. To anticipate the diffusion of HEVs, DOI researchers look to new car buyers with higher education and socioeconomic status, perhaps with a history of being the first to buy new technologies in the past (either in general or domain-specific, i.e., automotive). The motives of the first to buy HEVs, i.e., innovators, are explained by their general love of technology, along with their willingness and resources to pay a premium to be the first to own and try out the new HEV drivetrain. After gaining experience with this technology, such as testing performance, reliability, and fuel savings, these innovators provide feedback within their social network that diffuses to early adopters. Upon receiving this information through various communication channels, early adopters may envision the HEV as having mass market appeal, and through their channels of influence, accelerate the diffusion of positive HEV information, potentially stimulating a jump in demand that eventually overtakes the market. Heeding Moore's (1999) notion of a chasm, the success of HEV adoption may depend on the technology's ability to transition in appeal from early adopters to the early majority, where an inability to meet the needs of the mass market would result in failure, or constraint to a niche market.

Although my illustration is simplistic, it does not stray far from common applications of DOI. For instance, one study uses DOI's adopter categories to determine the status of HEV diffusion in Switzerland, comparing the general preferences and socioeconomic characteristics of HEV buyers and conventional vehicle buyers (de Haan, et al., 2006). Upon finding a significant difference between buyers, the authors conclude that at the time of the study, diffusion must have been at the early adopter stage, implying there was potential for further diffusion into the mass market. Santini and Vyas (2005) similarly applied the DOI framework to the U.S. HEV market, also finding that current HEV owners tend to be of higher socioeconomic status than average car buyers. Accordingly, the authors warn that the HEV market might be heading towards Moore's chasm, where only a careful transition to mass market appeal will assure success. Both studies highlight the tendency for the DOI approach to describe adoption as the diffusion of a functional technology between adopter categories, and are subject to similar limitations as described in the following paragraphs.

There are several general criticisms of the DOI approach to adoption, some of which are acknowledged by Rogers (2003). First, the concepts and language of DOI are deeply rooted in the nature of early diffusion research, that is, retrospective analyses of successful innovations (e.g. Coleman, et al., 1957; Rogers and Kincaid, 1981; Ryan and Gross, 1943). Thus, DOI has an inherent "pro-innovation" bias, providing little insights into innovations that fail, where the lack of a complete S-curves prevents the derivation of adopter categories (Rogers, 2003, p110-116). Perhaps more important for the case of pro-societal cars is retrospective bias, where DOI is best suited to describe adoption after the diffusion process has been completed, limiting the ability to apply DOI in a predictive or prospective manner. As illustrated by the two HEV studies cited above, researchers can only attempt to estimate the current stage of diffusion based on the traits of current adopters, which are matched against Rogers' adopter categories. Moreover, the retrospective bias causes difficulty in forecasting the size of the social system, or potential market, and how its size and composition might change over time.

Second, Rogers (2003) notes that DOI research does not typically address the broader context of diffusion beyond the individual adopter. Blaut (1987, p37) introduces two terms that can help explain such misinterpretations: *dependent diffusion*, where the diffusion of one innovation depends on another but is misread as independent, and *phantom diffusion*, where "diffusion is inferred to have taken place when none in fact did." For instance, the adoption of an innovation could be influenced by government policy, competition with other innovations, and manufacturing and logistical limitations—each of which would have nothing to do with the diffusion of information among individuals in adopter categories. Phantom diffusion is particularly relevant for the case of electric-drive vehicles, where adoption rates can be influenced by emissions regulation, tax incentives, product shortages and wait lists, slow stock turnover among consumers, and long manufacturing lead time of several years that can delay market feedback. Any of these external factors could impact the observed adoption curve of HEVs in Figure 1—failure to account for such external factors can lead to erroneous conclusions about observed adoption rates. In addition, dependent diffusion may occur between various manifestations of pro-societal cars, such as the potential for positive experiences with HEVs to spillover to perceptions of PHEVs or EVs.

Third, Rogers (2003) notes that DOI research has yielded little understanding regarding the underlying motivations of adoption. Typically, “economic motivation is assumed to be the main thrust for an individual’s adoption of an innovation”, but he admits, “the desire for prestige is probably very important in decisions to adopt certain innovations, such as new clothing fashions, new-model cars (such as ‘hybrid’ autos), and very thin laptop computers” (Rogers, 2003, p115-116). However, little research has been conducted on the importance of such motivations for different types of innovations, and how diffusion processes concerning prestige or other symbolic values might differ from functional information. Similarly, the reliance on innovativeness as an explanation of the time of adoption has limited usefulness. Hirschman (1980, p284) criticizes the vague nature of innovativeness as a trait, where “origins and causes remain obscure,” and “few attempts have been made to chart the development of innovativeness within an individual over time.” She notes that although DOI analysts may infer innovativeness to be genetic, the fact that it is correlated with dynamic measures such as education and socioeconomic status suggest that innovativeness may be socially influenced. Hirschman (1980) further notes that the tautological definition of innovativeness as early adoption makes it problematic to use such a measure to predict early adoption.

There are also several limitations of DOI specific to the present application to complex, dynamic innovations such as electric-drive vehicles and pro-societal cars. First, referring back to Table 2, DOI primarily focuses on the *private-functional* attributes of an innovation, as seen in foundational studies of corn seeds and pharmaceuticals, without explicit consideration of symbolic or societal perceptions (Hirschman, 1981). One of the most important attributes of the innovations is thought to be relative advantage, which is typically measured in economic terms. Similarly, Moore's chasm model was initially developed from observations of high-tech products, mainly business-to-business, also focusing on innovations with primarily functional importance. Thus, traditional DOI may be "inappropriate for describing the diffusion process of symbolic innovations" (Hirschman, 1981, p538), and may also be inappropriate for innovations with societal attributes.

DOI also tends to assume that the innovation itself is static throughout the diffusion process. To address this limitation, Rogers (2003, p17) offers the term *reinvention* as "the degree to which an innovation is changed or modified by a user in the process of implementation," but admits DOI research is not well-established for diffusion cases with substantial reinvention or other forms of modification. This criticism is important for the case of electric-drive and other pro-societal cars, where not only is the physical nature of such a technology likely to change substantially over time (given the variety of design possibilities), the overall pro-societal car vision can be shifted and adapted according to the many different perception of symbolic and societal attributes among different groups.

Another criticism is the vague and static system boundaries in DOI. Typical definitions of the social system or market suggest that the targets of analysis should be groups of closely related individuals with "a common goal" (Rogers, 2003, p23) or a "common set of needs…who reference each other" (Moore, 1999, p28), such as small social groups and communities. Instead, DOI is often applied in an aggregated manner, describing the total sum of potential adopters, or a national market. However, given the many different potential attributes of pro-societal cars, we might expect different social groups to have different goals or needs, where an aggregated "S-curve" misses the finer details of diffusion. Additionally, as such complex innovations diffuse the nature and composition of the relevant social group may change also.

A final criticism I address here is offered by Blaut (1987, p32), who disputes the conceptualization of adopter categories, which he calls *diffusionism*—the assertion that all innovativeness occurs "within the core" of a social system, driven by "some psychological or spiritual factor such as rationality, technological inventiveness, imaginativeness, (or) a logical theoretical mind." Innovations supposedly then diffuse to the periphery, consisting of the less innovative communities and individuals, according to "the principle of ideological contagion: certain ideas diffuse for no reason other than their innate infectiousness and the inherent susceptibility—in this case, the imitativeness—of the recipients" (Blaut, 1987, p32). Blaut (1987, p34) does not suggest that diffusion does not occur at all, but instead suggests the core-periphery notions of diffusionism be replaced by a *uniformitarian* approach, asserting "that in all human communities we should expect to find the same capacity for creation and invention…innovation should have equal probability of occurring in all places." He further introduces the term *crisscross diffusion*, where invention and re-invention (modification) will be "generated, transmitted and received…at all times novel traits will be crisscrossing the landscapes" (Blaut, 1987, p36). Following this notion of crisscross diffusion, we might expect the pro-societal car to be not just a static idea that diffuses outwardly from the core of innovators, but instead a dynamic concept that follows a process of continual reinvention across different segments of the population.

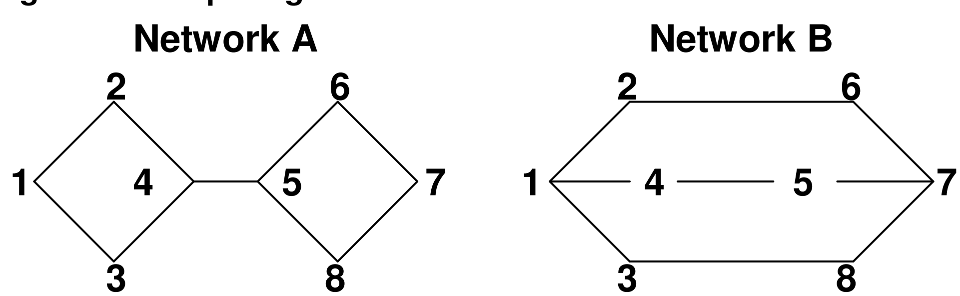
Social networks analysis

While traditional DOI approaches emphasize the individual as the unit of analysis, one branch of diffusion research employs tools from network analysis to explore 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 (Degenne and Forse, 1994). More broadly, Borgatti et al. (2009, p894) describe how "a key task of social network analysis has been to invent graph-theoretic properties that characterize structures, positions, and dyadic properties (such as the cohesion or connectedness of the structure) and the overall 'shape' (i.e., distribution) of ties." Social network approaches to diffusion use many of the same principles of DOI. However, rather than focus on innovativness, the timing of adoption is primarily determined by the *network connectedeness* of the individual—a measure that is positively related to innovativeness (Rogers, 2003, p330). For instance, individuals with many ties are more likely to adopt earlier (Rogers and Kincaid, 1981), a finding that corresponds with the DOI notion of early adopters being more cosmopolitan.

Instead of representing aggregated categories of adopters, the use of social networks allows a more detailed representation of social systems as a pattern or structure of interpersonal communication determined by a given factor such as "who talks to whom"

(Valente, 1995, p2). Figure 8 depicts two hypothetical networks from Degenne and Forse (1994) to illustrate the potential influence of social structure on diffusion patterns. Although both networks have the same linkage density (the number of effective links divided by the number of potential links), if all else is held constant, including the quality of the links, the diffusion of information is likely to be more rapid and complete in Network B. Also notice the particular importance of the connection between individuals 4 and 5 in Network A; if this linkage is blocked, further diffusion is impossible. Granovetter (1973) discusses the importance of this phenomenon in social networks, where the existence of *weak ties*—interpersonal connections scoring low in time, intimacy and reciprocity—are more likely to serve as bridge linkages between social clusters, and can ultimately do more to create cohesion in an extended social network than a prevalence of *strong ties*.

Figure 8: Comparing network structures



Source: Degenne and Forse (1994, p4)

Of course, social networks can be represented in far more detail than the simple depictions in Figure 8, such as accounting for the degree of intimacy, proximity and structural equivalence in individual ties. Rogers (2003, p308) identifies several methods of collecting data to represent a social system, such as the sociometric method which consists of directly “asking respondents whom they sought (or hypothetically might seek) for information about a given topic, such as a particular innovation.” Data can also be collected through a smaller group of key informants, self-designation, or observation (Rogers, 2003). For instance, in one of the first applications of network analysis to DOI, Coleman et al. (1957) followed the adoption of a new pharmaceutical among physicians with a sociometric method, asking physicians to name other doctors with whom they frequently discussed patients cases, as well as which doctors they considered to be friends. Results indicated that the degree of interconnectedness of physicians was a better predictor of adoption than their personal characteristics, particularly the friendship variable.

Social network analysis is subject to many of the same general limitations as DOI: retrospective bias, exclusion of external events (potential for phantom diffusion), and lack of understanding the underlying motives of consumers. There also similar limitations specific to more complex innovations, that is, by focusing on information about static, private-functional attributes that diffuse within a static social network. Identifying the relevant social network can also pose a challenge, where Bandura (2006, p123) notes “there is not a single social network in a community that serves all purposes...different innovations engage different networks.” It can be very difficult to predict which social network will be relevant for a given innovation at a given point in time.

Valente (2005) notes other limitations. Detailed network data can be very difficult to collect; the most well-known datasets were collected from small and isolated or bounded communities such as small-town farmers. In contrast, the expansive, highly integrated nature of today's markets and social system greatly complicates data collection. Also, network analysis does not always allow clear understanding of the importance of network structures and effects. For instance, there is potential for correlations between decision to adopt and membership in social network with others who are also likely to adopt, which is vulnerable to spurious associations (Valente, 2005). Valente (2005) explains that although original analysis of the medical innovation data from Coleman et al. (1957) suggests the importance of social network influence, more recent re-analyses finds no evidence of social influence playing a role once publicity, aggressive marketing and other external events were accounted for (e.g. Valente, 1995; Van den Bulte and Lilien, 2001). He summarizes that "given the number of confounding factors and some of the data requirements, it may be prohibitively difficult to substantiate the role of social networks in innovation adoption via survey methods alone" (Valente, 2005, p113).

In fairness, social network analysis covers a much broader set of applications than I have represented here. Borgatti et al. (2009) note that networks can be based on a variety of tie definitions, including similarities (e.g. location, group membership, common attributes), social relations (e.g. kinship, other roles, affection, cognition), interactions (e.g. talking, helping, harming) or flows (e.g. information, beliefs, resources). Further, while diffusion is a particularly popular application of social network analysis, alternative theoretical mechanisms include other types of flows or "direct transmission" (e.g. material), bonding and exclusion (Borgatti, et al., 2009, p894-5). However, many of the limitations and criticisms outlined should be considered in any type of social network analysis.

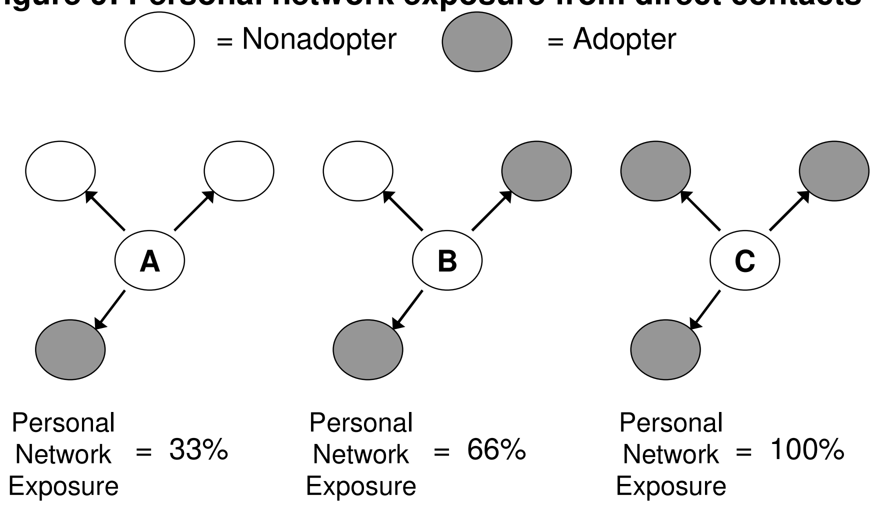
2.3.2 Conformity: Thresholds, social learning and social norms

A second perspective, which I call *conformity*, focuses on the role of an individual's perceptions of what others are doing or expecting. Conformity includes applications of threshold modeling, social learning theory, and social norm research. The conformity perspective is not as unified as DOI, and does not discuss specific processes of communication. However, conformity provides concepts and language to help understand processes of adoption decisions in social contexts, particularly among people who adopt later. Also, it helps to explore the dynamics of symbolism, where symbols require some degree of consensus among members of a social group in order for a particular meaning to be successfully conveyed.

Strang and Soule (1998, p283-284) describe *threshold models* as contrasting with the "point to point processes" depicted by DOI, and breaking "with the notion of direct contagion to view potential adopters as responsive to the distribution of present adopters in the population." Granovetter (1978) provides a classic threshold model of collective action or behavior, which he illustrates with an abstract example of rioting behavior. The system boundary for this example is a crowd, which is the relevant social group. The adoption of rioting behavior is determined by each individual's *threshold,* defined as the proportion of fellow crowd members that must engage in the rioting behavior before the individual will join. The first adopters are *instigators* with relatively low thresholds, while *conservatives* adopt later (or not at all) due to higher thresholds. Granovetter explores how different distributions of thresholds among the crowd can significantly influence the overall outcome, often in counterintuitive ways, concluding that the “most important causal influence on outcomes is the variation of norms and preferences within the interacting group” (Granovetter, 1978, p1421). Granovetter also demonstrates how thresholds vary according to the relationships between individuals, where a friend’s behavior may be weighted more heavily than that of a stranger. Granovetter (1978, p1441) cites the main strength of threshold models to be in “helping to understand situations where outcomes do not seem intuitively consistent with underlying individual preferences.” He illustrates this point with the case of a group of delinquent boys that steal cars to maintain status, where each individual boy acts contrary to the norms they personally hold, e.g. “stealing is bad,” in order to impress others in the group. In other words, their collective behavior appears to contradict their individual preferences.

The threshold approach has also been used to explore patterns of adoption within social networks. Valente (2005) describes a simple model where an individual’s adoption is determined by their personal network exposure—the percentage of individuals in their personal network that have already adopted the innovation. Figure 9 demonstrates three different hypothetical individuals (A, B and C) with varying levels of personal network exposure. All else held constant, an individual would be most likely to adopt with higher personal network exposure, i.e., more people in the relevant network having already taken up the new thing or behavior. An individual with a lower threshold requires less exposure than one with a higher threshold. More sophisticated models weight the influence of various individuals by physical or social proximity, similarity of social environment (structural equivalence), or other factors.

Figure 9: Personal network exposure from direct contacts



Source: adapted from Valente (2005)

Similar to the trait of innovativeness in DOI, threshold models typically "do not consider how individuals happen to have the preferences they do" (Granovetter, 1978, p1421). However, more detailed conceptualizations of the mechanisms behind thresholds can be drawn from two related research areas: social learning theory and social norms. *Social learning* is based on the same premise as threshold models, where the likelihood of adoption "varies in response to how common the behavior is in a relevant social group" (Efferson, et al., 2008, p1). The driving force behind this premise is not just mimicry, but a process of learning from the outcomes of others in order to increase personal benefits (Efferson, et al., 2008). In other words, the individual's threshold preferences are based on their ability to glean useful information from the behavior of the group. Another perspective explains thresholds as being driven by *social norms*. Cialdini (2003, p105) describes two classes of norms: *descriptive norms* as "perceptions of which behaviors are typically performed", and *injunctive norms* as "perceptions of which behavior are typically approved or disapproved". Cialdini (2003) asserts that both types of norms can pressure individuals to adopt or not adopt certain behaviors.

Processes of conformity could influence the adoption of pro-societal cars in several ways. For instance, a car buyer may want to see a certain number of HEVs on the road, or purchased among friends, before they are willing to buy one too. A social learning explanation could be that such a threshold serves as a cue to better functional performance of HEVs, where higher incidence of other buyers is evidence of superior performance, reliability or realized fuel savings. Threshold effects could also work within smaller groups, where an individual wants to see a certain percentage of "fellow environmentalists" adopt before they are convinced of the societal benefits of the technology. On the other hand, the social norms perspective suggests that frequency information could be used to infer a common trend of HEV adoption (descriptive norms), or to interpret whether HEV adoption is becoming socially desirable (injunctive norms).

Threshold processes may be particularly relevant for understanding the symbolic attributes of pro-societal cars. In order for a particular meaning to become established for a vehicle—whether social prestige, technological advancement, environmentalism or some other message—a certain threshold of prior adopters will be required for the meaning to be successfully conveyed. In other words, even if an individual believes an

HEV is environmentally-friendly, they may wait until they are sure that others also have this belief before adopting, to assure this symbol will be successfully communicated to others in their social group.

Ultimately, although the conformity approach may assist in conceptualizing the influence of trends on adopters, little insight is offered as to how trends start. Like DOI's failure to explain why innovators act earlier, conformity perspectives lack explanation as to why instigators have lower thresholds and thus act before the mechanisms of social learning or social norms can play a role. The conformity approach does not explain the emergence of new behavior or innovations, nor does it explain where social norms come from, or how they can change.

Another potential direction of conformity research might apply to the early adoption problem by exploring what conditions facilitate non-conformity. I could rephrase the question from one of conformity ("how many people must act before I will"), to one of dissent ("how many people must act against the norm before I will"). This question may relate to the new pro-societal benefits of an electric-drive vehicle, which requires the buyer to shift away from the status quo of the race-travel-limo as a purely private good. In other words, there may be thresholds for non-conformity.

Consider Asch's (1955) classic conformity study. Subjects were instructed to complete a simple task (choosing the longest of three lines) in front of a group of actors pretending to be co-subjects. These actors would purposely choose incorrectly, exerting pressure on the subject to conform to their responses. For instance, when all of the three or more actors were united in an incorrect response, the subject would conform to the group's choice 32 to 37 percent of the time, overruling their own senses (compared to ~98 percent accuracy with no actors). However, if the subject had just one supporting co-subject (actor), even against a majority, the proportion of incorrect "conforming" responses dropped by 75 percent. Such findings might apply to the study of new social movements, investigating the thresholds of co-dissenters required to justify a break from the majority, such as the dominant vision of motor vehicles as simply private goods. This notion relates to the critical mass concepts discussed in the next section.

In summary, the conformity approach to adoption is incomplete for application to pro-societal behaviors and thus the purchase and use of electric-drive vehicles. Little or no explanation is offered regarding the origins of individual thresholds, or how incidences of adherence or non-adherence with new or pre-existing behaviors is perceived or communicated. Concepts of social norms and social learning are helpful for discussing the processes of later adopters, but do not address the motives of instigators. However, the conformity approach will yield useful insights into the development of symbolic attributes, and thresholds for behaviors of non-conformity.

2.3.3 Dissemination: Collective action and critical mass

Rogers (2003, p6) defines *dissemination* as "diffusion that is directed and managed." I use this term in relation to processes of *collective action* and *critical mass*, which apply specifically to issues of pro-societal goods.[6] As noted in Table 2, pro-societal cars can be associated with societal benefits which are not sufficiently accounted for in DOI. In an individually focused world, we expect societal goods to be under-provided, and pro-societal cars to be "under-adopted." In other words, why would an individual pay extra for an HEV to reduce environmental pollution when the next buyer can purchase an SUV and still benefit from my contribution? However the idea of *collective action* states that "the assumption that individuals act in isolation is usually wrong," where in most decisions "people are at least generally aware of what others are doing, and often they have social relations that make influence, or even sanctions, possible" (Marwell, et al., 1988). In other words, motivated individuals can interact and collaborate to provide pro-societal goods that would not have been provided otherwise.

Oliver et al. (1985) categorize societal goods according to the shape of the production function, which can be decelerating, accelerating, linear, S-shaped, or stepped. Societal goods with decreasing marginal returns (a decelerating production function) follow a pattern with "the first few units of resources contributed having the biggest effect on the collective good, and subsequent contributions progressively less" (Oliver, et al., 1985, p526). Alternatively, societal goods with increasing marginal returns (an accelerating production function) follow a pattern where "initial contributions of resources have only negligible effects on the collective good, and only after long start-up costs have been

[6] In tracing the development of critical mass theory, Oliver and Marwell (2001) note that in many places, diffusion literature has treated critical mass as a species of threshold model, often considering critical mass as a threshold or tipping point for the entire system. Such interpretations were not intended by the original critical mass theory, and in this dissertation I seek to maintain the original concepts.

borne do subsequent contributions start to make a big difference in the collective good" (Oliver, et al., 1985, p526).

It is not clear which production function best represents pro-societal cars like HEVs. Purely functional-societal benefits, e.g. the contributions of each HEV sold to reducing emissions and petroleum use, are relatively linear while private costs may decrease with the development of battery technology. However, because incremental functional-societal benefits are very small, symbolic-societal benefits may be more relevant—where the first few HEVs sold may have more influence in inspiring other consumers to "buy green" than later purchases. However, these initial HEV purchases may also involve higher private cost due to increased technological and symbolic risk; e.g., the batteries have not yet been proven as a viable technology, while the recognized meanings of the HEV are still being developed. Although it is not easy to match electric-drive vehicles to a specific class of production function, the above discussion illustrates potential applications of the dissemination approach to pro-societal cars, and further demonstrates the complexity of exploring their adoption.

The challenge of collective action is to get "some relatively small subset of a group interested in the provision of a public [or pro-societal] good to make contributions of time, money, or other resources toward the production of that good" (Oliver, et al., 1985, p524). Oliver et al. (1985, p542) state that cases with accelerating production functions are the most problematic, where resolution "depends on the rare circumstance of there being a critical mass of persons whose combination of interests and resources is high enough to overcome the feasibility problem." This *critical mass* is defined as a "pool of highly interested and resourceful individuals willing to contribute in the initial regions of low returns" in order to set up the conditions to sustain more widespread action (Oliver, et al., 1985, p543). Where DOI labels the first adopters of private goods innovators, in dissemination the first to adopt pro-societal goods are members of the critical mass, and, like innovators, critical mass members tend to have "extraordinarily high interest" and above average access to resources (Oliver, et al., 1985, p543).

Although typically applied to the study of formalized social movements, critical mass theory can be applied to private goods with societal attributes. Focusing on the diffusion of interactive media (e.g. telephone, email, etc.), Markus (1987) describes the accelerating production functions associated with high start-up network costs and susceptibility for free-ridership later on, a problem that is not sufficiently addressed by the DOI approach. Markus (1987, p505) highlights the importance of reciprocal interdependence, where the "outputs of one user are the inputs to another user and vice versa." For pro-societal cars, potential adopters that are truly interested in functional-societal attributes may face similar barriers; success in reducing pollution, greenhouse gases or oil use cannot be achieved by the individual alone, but also relies on previous and subsequent decisions by others to adopt (and not just vehicle choice, but in other energy-using actions also). A potential adopter might not just look to previous adopters for information, but may also assess the likelihood of further adoption. Where earlier adopters generally face higher private costs than later adopters, success of further adoption is improved by the intentional coordination among some critical mass of dedicated, resourceful pro-societal car adopters. This group acts not only through adoption of the particular vehicle technology, but also by testing, promoting and assigning value to the vehicles. These groups may be formalized in some cases, as seen with HEV driver groups, but in most cases are less formal networks of loosely connected social groups.

In another approach relating to collective action, pro-societal car adoption can be conceptualized as a form of *boycott*, described as a “pervasive and potent instrument of consumer discontent in today’s marketplace…to curb perceived market abuses and/or increase corporate sensitivity to their economic, political and social concerns” (Sen, et al., 2001, p399). The pro-societal car could be a way to reduce one’s oil consumption, or to purchase one less race-travel-limousine. Such motives may fit into the symbolic-societal cell of Table 2. Research on boycotts suggests that the likelihood of an individual joining a consumer boycott is determined by their perceptions of boycott success, susceptibility to normative influences, and private costs of the boycott (Sen, et al., 2001). Perception of success further depends on overall expected participation (Sen, et al., 2001). Thus, related to the thresholds concept discussed earlier, an individual is more likely to adopt a pro-societal car if they are convinced that their efforts will be successful, that others will also adopt, and of course, that the cost premium is not prohibitively high. Again, a critical mass of motivated early adopters can help to mediate these conditions.

In summary, the dissemination approach to diffusion can assist in conceptualizing efforts to coordinate the adoption of innovations with societal and symbolic attributes. While the pro-societal car movement and the critical mass that initiates and sustains it are likely to be less formalized than conventional applications of critical mass theory, the provided concepts and language may be useful for further investigation of innovations involving the patterns of production functions and reciprocal interdependence among buyers.

2.3.4 Translation: Social construction and interpretation

The fourth perspective, *translation*, draws from *social construction of technology* (SCOT) and *actor-network theory* (ANT)—though only the latter actually uses the term translation. Taken together, these approaches provide a rich set of concepts and language to explore the development and adoption of innovations as dynamic, socially defined artifacts.

Social construction of technology (SCOT)

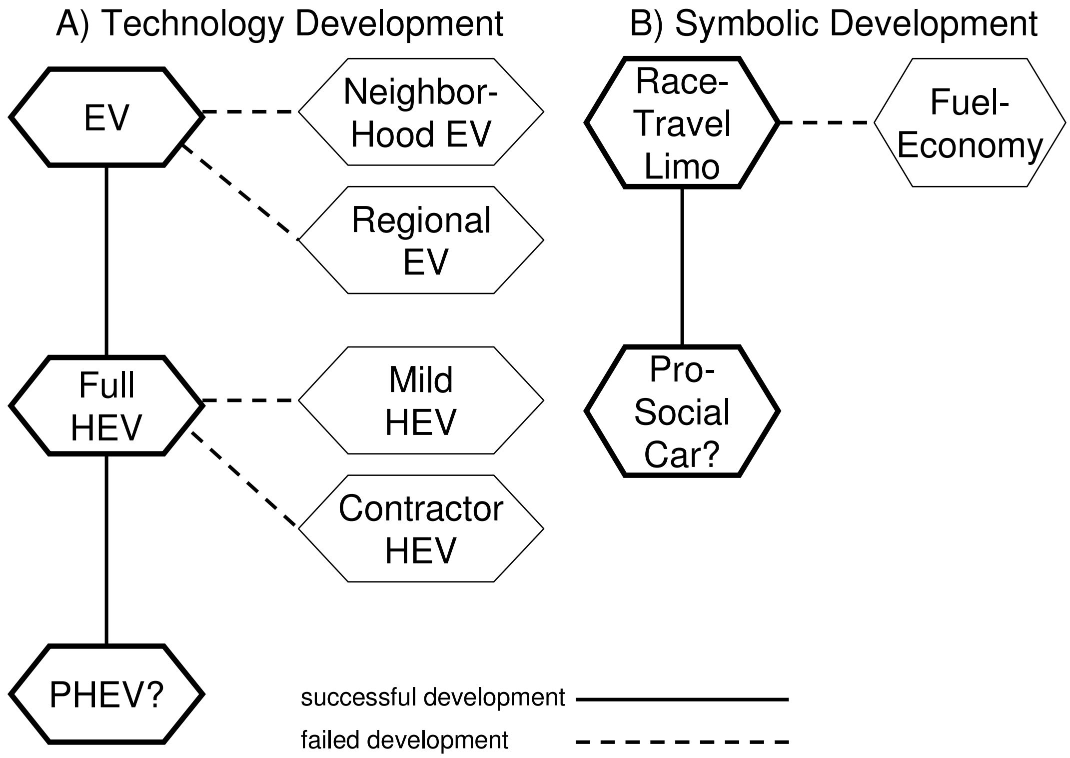
SCOT looks beyond the notion of adoption being driven by the diffusion of a functionally advantageous technology (Bruun and Hukkinen, 2003). Instead, technological change is described as "the culmination of a social process of interactions that (lead) to changed attitudes towards the (technology) and its use" (Bruun and Hukkinen, 2003, p110). The development of a technology follows a "multi-directional" process, where success in a given direction is determined by the changing problems and interpretations of relevant social groups (Pinch and Bijker, 1984, p411).

A newly introduced *artifact*—a term that emphasizes the cultural element in making and shaping the innovation of interest—has a high degree of *interpretive flexibility*, where social groups have differing interpretations of its meaning and content which influence further technological development (Pinch and Bijker, 1984). These interpretations are "socially and culturally embedded" where individuals in a particular social group tend to have a common perception of a given artifact, known as a *technological frame* (Bruun and Hukkinen, 2003, p102), where in some cases the shared frame is what defines the social group. Eventually the stages of interpretive flexibility (or controversy) reach a state of *closure* and stabilization where the perspectives of various social groups converge with the "streamlining of interpretations" among them (Bruun and Hukkinen, 2003, p101).

SCOT was originally developed for the design stages of a technology, including engineering and manufacturing decisions (e.g. Pinch and Bijker, 1984). Kline and Pinch (1996, p767) extend SCOT to analyze the use stage of innovations, exploring the "reciprocal relationships between artifacts and social groups…how the identities of social groups are reconstituted in the process." Focusing on early automobile use among rural Americans, the authors illustrate how the "anti-car crusade's" initially negative interpretations of automobiles were gradually overcome by positive interpretations that were both functional (e.g. providing stationary assistance for farm tasks) and symbolic (e.g. reinforcing gender roles). In addition to demonstrating how different social groups can shape the development of a technology, Kline and Pinch (1996) highlight how the development of the auto also transformed the rural social groups, increasing the connectivity of communities and allowing new methods of saving labor.

The social construction process can be represented visually, as demonstrated by Pinch and Bijkers's (1984) application to the Penny-farthing bicycle, using a conceptual diagram to depict relationships between social groups and their problems, and artifacts and their solutions. In Figure 10, I adapt Pinch and Bijker's (1984, p413) diagram to the case of electric-drive vehicles and pro-societal cars. Part A presents one conceptualization of how electric-drive vehicles might have developed in the U.S. auto market. In the early 1990s, full-performance EVs such as GM's EV-1 proved unsuccessful. Further development could have followed multiple paths, including lower-range, lower-power neighborhood or regional EVs, or the development and deployment of HEVs. Ultimately, HEVs proved successful with the release of "full" HEVs, such as the Honda Insight and the Toyota Prius. As these vehicles gained popularity, other manufacturers released alternative models utilizing drivetrains with less fuel efficient hybridization (e.g. Honda Accord Hybrid) or applying hybridization to the use of power tools in "contractor" applications (e.g. Chevy Silverado Hybrid). Both alternate pathways have so far failed to achieve market success, while the PHEV is achieving substantial attention as the next potential stage of development.

Figure 10: Illustrative depiction of quasi-linear development of innovations



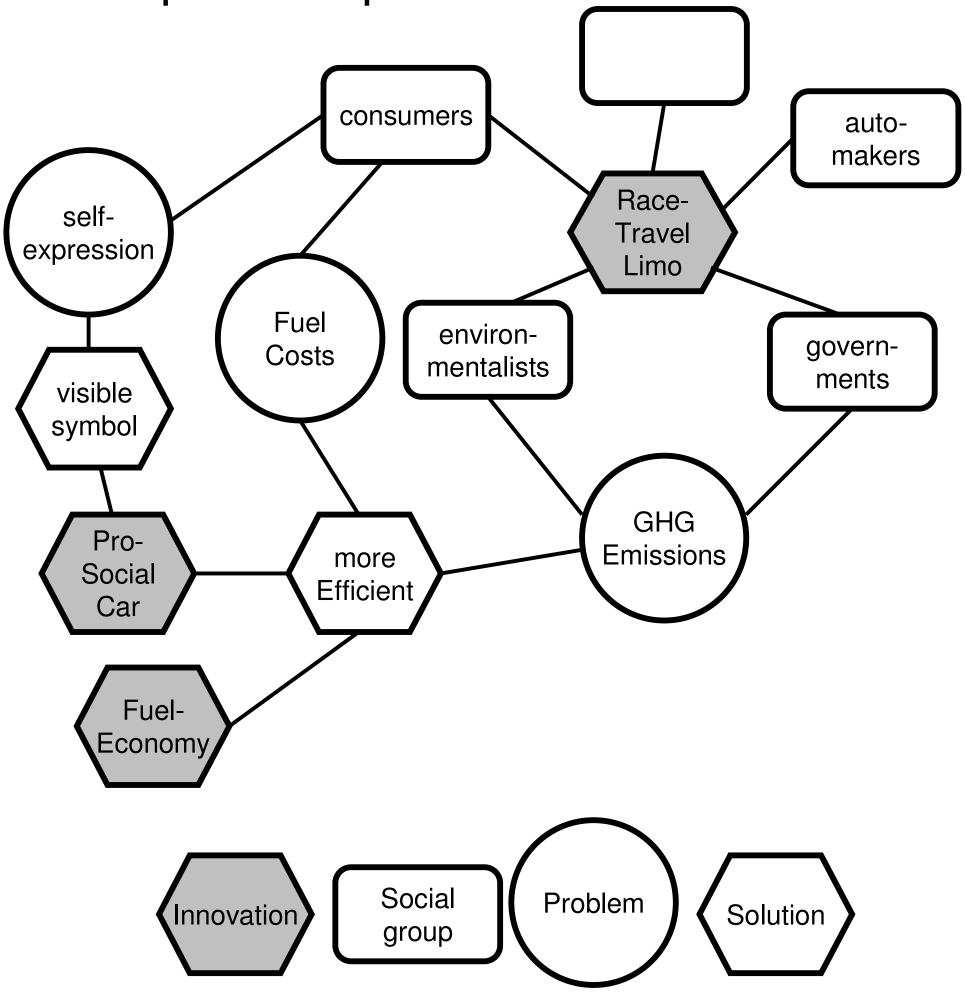
Source: Adapted from Pinch and Bijker's (1984, p413) depiction of the Penny-Farthing Bicycle

Part B of Figure 10 conceptualizes the development of pro-societal cars on a symbolic level. Starting with the dominant race-travel-limo vision of automobiles described in Section 1.4, the practical notion of fuel economy emerged as a potential alternative pathway in the aftermath of the energy crises of the 1970s, moving towards smaller, cheaper, more fuel efficient cars. However, this pathway gradually disappeared with the advent of less efficient minivans and SUVs in the 1980s—regressing back to the race-travel-limo vision. More recently, with the growing popularity of HEVs, the pro-societal car concept has emerged as a potential contender.

While the diagrams in Figure 10 help to conceptualize the trajectory of different technologies and symbols, the true strength of SCOT is to illustrate how the interpretations of various social groups guide this development process. Figure 11 is another adaptation from Pinch and Bijker (1984, p418), where I illustrate the potential drivers of the symbolic development in Part B of Figure 10. The dominant vision of the race-travel-limo is represented in the gray hexagon, surrounded by several social groups with differing interpretations of what problems need to be solved by technological developments. For instance, general consumers may be concerned about high gas prices, while environmentalists and governments are focused on reducing greenhouse gas (GHG) emissions.

The fuel economy technology is presented as a potential direction of development, consisting of smaller, more fuel-efficient vehicles using conventional gasoline engines. This efficiency solution solves one problem of consumers (fuel costs) and one problem of environmentalists and governments (GHG emissions). However, general consumers have the additional problem of desiring a form of self-expression, which they interpret as being unachievable by the smaller, cheaper, low-power fuel economy vehicles (which are associated with low income). In contrast, pro-societal cars emerge as a technology that not only reduces fuel costs and GHG emissions through increased efficiency, but also provide a visible, higher price, technologically advanced symbol that appeals to the symbolic needs of many consumers. If other social groups eventually yield similarly positive interpretations of pro-societal cars, the overall interpretation of the pro-societal car as successor to the race-travel-limo could reach a state of closure.

Figure 11: Illustration of relevant social groups, problems, and solutions in the development of the pro-social car



Source: Adapted from Pinch and Bijker's (1984, p413) depiction of the Penny-Farthing Bicycle

Brown (2001) provides a further addendum to the original SCOT approach, asserting that certain social groups within the SCOT framework can have particularly powerful influence over the interpretations of other social groups. For instance, when the California Air Resources Board (CARB), a government agency, established the zero-emissions vehicle (ZEV) program in the early 1990s, clean air benefits were highlighted as important criteria in the technological development of vehicles. Brown (2001) argues that CARB's statements and actions served to reopen the interpretive flexibility of the race-travel-limo vision, prompting consumers to consider social attributes as an important concern for buyers of motor vehicles. Thus, social groups beyond individual adopters can play an important role in influencing the interpretations of consumer groups.

Overall, SCOT is useful for conceptualizing the dynamics of an innovation, the social groups that can guide development (including non-consumers), and the interplay between competing problems and interpretations. However, SCOT alone is not sufficient to explore the diffusion and purchase process; its origins in design stage applications make it less appropriate for more complex problems of user groups and symbolic interpretations. For instance, Hannemyr (2003) notes that the SCOT concept of closure is overly definitive, where interpretations may streamline at times, but may not fully converge, and any convergence may only be temporary. Moreover, SCOT does not account for processes of social action in technological controversies, or explain how the overall structure of social groups may be heavily influenced or even defined by the technology (Bruun and Hukkinen, 2003).

Actor-network theory (ANT)

Due to such limitations of SCOT, researchers often draw from its less tangible cousin: *actor-network theory* (ANT) (e.g. Bruun and Hukkinen, 2003; Hannemyr, 2003). The abstract nature of ANT is a strength and weaknesses. Unlike SCOT, which conceptualizes a structure of roles and relationships among social groups and technologies, ANT provides a level playing field for all *actors*—including people, groups, ideas, objects and infrastructure. The only differences among actors are the "methods and materials that they deploy to generate themselves" (Law, 1992, p390), where relationships and social structures are extremely dynamic. All actors "take their form and acquire their attributes as a result of their relations with other entities" (Law and Hassard, 1999, p3). Similar to later applications of SCOT, ANT asserts that while social structure can influence technological change, the reverse is also true. The difference is that ANT steps further in stating that a social group can only be defined by its relationship with the technology and other actors; every actor is defined by its interactions with other actors. Taken in another light, while SCOT states that technologies are socially defined with malleable interpretations, ANT states that the entire network, social and otherwise, is just as fluid.

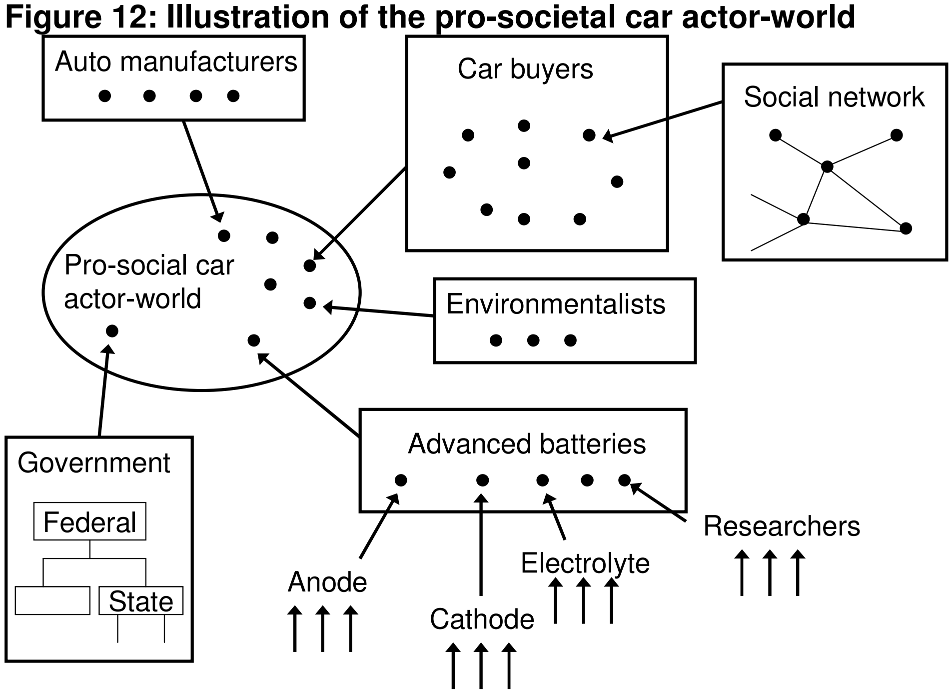
The concept of *translation* is perhaps the greatest contribution of ANT to a discussion of alternatives to DOI. Where diffusion represents the propagation of a static idea or object, translation emphasizes that these ideas and objects change as a result of context and interactions among actors (Pentland and Feldman, 2007). Bruun and Hukkinen (2003, p107) define *translation* as "the mechanism through which actors can transform themselves, displacing their own identity as well as that of others." 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 the communication process. For instance, information regarding the symbolic and pro-societal attributes of a technology may be highly subject to translation, where interpretations of meaning are continually refined and negotiated among users and observers.

ANT also provides a less definitive concept of closure than SCOT, where an innovation may have multiple scripts which are "mediated, translated, and even changed as time passes, being the product of domination, negotiation, and mutual adjustment" (Hannemyr, 2003, p113). Instead of a finalization of interpretations, ANT presents the concepts of *alignment*, measuring the degree of agreement for a certain translation, and coordination, the restriction of interpretive flexibility by rules or conventions (Callon, 1991). Thus, while translations may occasionally streamline through negotiations among social groups, they are always open to revision.

Callon (1986) applies ANT to the case of electric vehicles in France during the 1970s. He describes how Electricité de France's (EDF) presentation of a plan for the deployment of EVs could be represented as an actor-world—a vision of the roles required by all relevant actors. Callon describes that for EDF's vision to play out, consumers would have to be interested in buying the EVs, automakers would have to be willing to shift manufacturing efforts, governments would have to enact pro-EV legislation, and electrochemical batteries—another actor and network of further components—would have to perform adequately. In this sense, Callon describe the EDF as a "spokesman" for the actor network, translating the roles and relationships among actors. In turn, any of these actors, including car buyers, automakers, governments or batteries, can reject such assigned roles and thus prevent the envisioned actor-world from manifesting. Callon (1986, p32) summarizes that the actor network is "distinguished from a simple network because its elements are both heterogenous and are mutually defined in the course of their association."

Figure 12 presents a potential actor-network perspective on electric-drive vehicles, adapted from Callon's (1986) portrayal of EVs in France. The relevant actor-world is made of many different actors, each of which contains its own network of sorts. The structure of each network may differ: car buyers may include different social networks, governments include a hierarchical order of bodies, and advanced batteries are made up of specific components which are made up by still more specific components and organized by researchers.

Figure 12: Illustration of the pro-societal car actor-world



Source: adapted from Callon (1986).

In application to pro-societal cars, ANT provides flexibility to the relatively rigid structure of SCOT. For instance, ANT allows for every item in Figure 12 to experience transformation over the processes of development and adoption, including the technologies, social groups, problems and solutions. For instance, the social groups are in part defined by their interpretations of motor vehicle technologies, and some interpretations of problems (e.g. greenhouse gas emissions) may not have emerged until after the presentation of their solution (e.g. pro-societal cars). The translations of other social groups may stimulate an individual to reinterpret their own problems. The individual may then become part of a new social group of green drivers whose existence results from the emergence of pro-societal cars, rather than preceding it.

However, as noted, the flexibility of ANT is also a weakness for the present application. ANT includes no causal theory of action (Bruun and Hukkinen, 2003), and can not serve as a predictive model of adoption. However, taken as a supplement to the rigid structure of SCOT, the concepts and language of ANT enhance the ability of the translation perspective to facilitate the discussion of adoption processes, including the roles of and relationships among multiple heterogeneous social groups, and the dynamic, reciprocal relationships between all the actors involved, including the innovation itself. Overall, the explicit incorporation of individual and group-based interpretations and translation can aid the investigation of innovations with attributes in all categories of Table 2.

2.3.5 *Reflexivity: Modernity and the project of the self*

A final perspective explored in this paper is Giddens' (1991) approach to self development in the social world. Although this perspective does not specifically focus on consumer products or adoption, Giddens theorizes about the underlying driving forces of human behavior (including adoption) which have been neglected in the perspectives presented thus far. While other perspectives offer surface level descriptions of the mechanisms involved in the adoption process, including diffusion, conformity, dissemination and translation, none satisfactorily explore the drivers behind these mechanisms. Unanswered questions include: why develop new technologies in the first place? Why adopt them? Why use symbols? Why spread information about new technologies? Why be concerned with the societal good? Why be concerned with problems, interpretations and translations in the first place?

I take Giddens' description of modern life, which acts to "propel social life away from the hold of pre-established precept or practices" (1991, p20), as the overall context for the generation and diffusion of new behaviors. Contrasting with traditional times, where an individual had a set role and expected set of behaviors and interactions with others, the modern world provides no such organization. Instead, *modernity* is characterized by uncertainty, where individuals must actively seek out and define their self identity. Without the guidance of traditional roles, "the self becomes a reflexive project" (Giddens, 1991, p32), where *reflexivity* is defined as the dynamic, continuous process of defining and expressing oneself. The self is understood through a reflexively defined biography, or narrative, linking an individual's past, present and future into a cohesive "trajectory of development" (Giddens, 1991, p75). This narrative must "continually integrate events which occur in the external world, and sort them into the ongoing 'story' about the self" (Giddens, 1991, p54). The ultimate goal of this process of self-exploration is self-actualization in the sense of authenticity or "being true to oneself" (Giddens, 1991, p78). In short, to cope with the immense uncertainty of modern times, human behavior is guided by efforts to establish a sense of order, direction and development for their self-concept.

Given the vast selection of choices an individual is faced with on a daily basis, Giddens' (1991, p81) describes the importance of *lifestyles* in providing guidance, defined as "a more or less integrated sense of practices which an individual embraces, not only because such practices fulfill utilitarian needs, but because they give material form to a particular narrative of self identity." Thus, instead of agonizing over every behavioral choice in efforts to be authentic, individuals seek a lifestyle as a package of practices that are associated with their particular trajectory. These practices include fashion, eating, and any other "means of symbolic display…giving form to narratives of self-identity" (Giddens, 1991, p62), which includes vehicle purchase and driving behavior. In essence, lifestyle is "the very core of self identity" in the context of modernity (Giddens, 1991, p81). However, a lifestyle is by no means a static package, but also follows a reflexive process, continually "open to change in the light of the mobile nature of self-identity" (Giddens, 1991, p81).

Giddens also describes *lifestyle sectors*, where in the course of daily life, an individual may subscribe to several different lifestyles. Sectors may be divided according to location, e.g. home and workplace, relationships, e.g. marriage and friendship, or activities, e.g. work and recreation. The lifestyle sector could be thought of as a dynamic and more theoretically elaborate version of the relevant social group concept discussed in other adoption perspectives. Similar to ANT, Giddens' description of reflexivity highlights the indefinite and relationally defined nature of lifestyle sectors. But Giddens adds to ANT a theoretical interpretation of why and how the process of translation occurs in human actors.

Notions of lifestyle and lifestyle sectors can explain aspects of other perspectives of consumer adoption. For instance DOI's concept of innovativeness may relate to a certain type of lifestyle adopted by individuals who define themselves as cutting edge, technologically advanced individuals, and the practices of this lifestyle include the purchase and use of new technologies. In addition, the critical mass groups described in the dissemination perspective may represent another lifestyle adopted by people who want to develop and portray themselves as environmentally aware, socially active individuals, including the practice of driving pro-societal cars and helping to establish positive interpretations of their pro-societal benefits.

In Giddens' (1991, p221) framework, increased ecological concern among individuals relates to the "recognition that reversing the degradation of the environment depends upon adopting new lifestyle patterns." Thus, the adoption of pro-societal cars is not just driven by a motivation for advantageous functional or symbolic attributes, but may instead be one component, or trial, of a more fundamental shift towards an environmental or socially-conscious lifestyle. The visible nature of the pro-societal car can facilitate reflexivity by prompting users and observers to share and negotiate interpretations. Observers may speculate as to the motivations and lifestyle choices of the driver, assessing if such a practice might fit into their own self trajectory. After adoption, a user may solidify initial interpretations of the vehicle, or modify interpretations based on their experiences and feedback from personal contact and the media. Thus, similar to ANT, the context of modernity is subject to continuous uncertainty and revision of interpretations and meaning.

To understand how reflexivity affects the adoption of pro-societal values, it is important to understand why some individuals are open to new lifestyle practices, while others are not. Similarly, a given individual may be open-minded at one point in time, and more firmly dedicated to their self-concept at other times. In other words, an individual's self-concept and commitment to lifestyle practices may be more or less stable subject to different conditions. This notion relates to Turner's (1969, p95) conceptualization of *liminality* as a state in which an individual is "betwixt and between the positions and assigned by law, custom, [and] convention." A liminal state is characterized by "ambiguous and indeterminate attributes," (p95) which contrast with the clearly defined attributes of a stable "status system" (p106). Turner (1969, p112-3) describes how liminality can be induced as a temporary state, e.g. through ritual practices in some cultures, or how it can be embodied in a community, such as "hippies" who "opt out of the status-bound social order," and emphasize "spontaneity, immediacy and existence" as a direct contrast with the structure of society around them. Of course, over time the structure of this "hippy" society has stabilized, and is now associated with set of clear lifestyle practices.

In any case, the concept of liminality may be a helpful complement to the reflexivity perspective by helping to identify states and conditions under which an individual is more likely to consider altering their self-concept and lifestyle practices. Liminality may be associated with an individual's life stage, where they experience higher liminality (and thus more openness to new lifestyle practices) as a college student or new retiree, and less liminality (more stability) as a parent with responsibilities to care for young children. Liminality may also relate to the structure of an individual's social network, including the diversity of individuals and social groups that they interact with. In this sense, processes of reflexivity for a given individual may be associated with the stability or liminality of their self-concept and lifestyle practices.

Ultimately, the reflexivity perspective is not meant as a stand-alone approach to adoption behavior. However, it does provide a theoretical backdrop to the other approaches described in this Chapter. Most notably, Giddens supplements the translation approach, particularly ANT, by explaining how and why the multi-directional relationships among actors occur.

2.4 Conclusions: Towards an integrated perspective?

Chapter 1 explored the complex nature of PHEVs in their potential to offer important functional, symbolic and societal benefits. In this Chapter I reviewed how the dominant perspective on adoption, the DOI approach, focuses on the communication of information concerning the functional attributes of an innovation among adopter categories. DOI is not conceptually equipped to explain the additional complexity of symbolic and pro-social behaviors or artifacts. The exploration of four alternative approaches, which I label conformity, dissemination, translation and reflexivity, yields insights into the complexities of the adoption process for different aspects of an innovation. Conformity highlights how observing the behaviors of others can influence individual interpretations of the innovation, as well as tendencies to join or oppose existing social norms. Dissemination explores the adoption of goods with pro-societal attributes, addressing the important role of early adopters willing to accept high start up costs, known as the critical mass. Translation describes the socially dynamic nature of innovations, where interpretations are continuously redefined and renegotiated among social groups that are themselves being redefined and renegotiated. Finally, reflexivity provides a theoretical backdrop to the underlying motivations of adoption processes, describing the individual as a work in progress, continually searching for self development and expression through lifestyle practices.

Table 4 presents a summary of how the five perspectives address the five questions posed at the beginning of Section 2.3. The bottom row highlights the types of innovation attributes a given approach may be designed or particularly well suited for—as conceptualized earlier in Section 1.4 and Table 2. Note that these perspectives are in some sense complementary; viewed together, each of these perspectives may yield insights into how interpersonal processes influence the adoption of electric drive vehicles. DOI was designed, and is suited, primarily for private-functional attributes and the flow of functional information; conformity holds potential for symbolic attributes; dissemination describes intentional efforts to promote the adoption of innovations with pro-societal attributes; and both the translation and reflexivity approaches address all types of attributes through the interpretations of individuals and social groups. However, no single approach seems adequate for the study of pro-societal vehicle purchase behavior—not even the last two; translation does not discuss specific mechanisms of communication and adoption behavior, while reflexivity only provides a theoretical backdrop to processes of adoption.

This review does not suggest that each approach should be independently applied to the different attributes of a technology. Such a patchwork of concepts and language would not be particularly useful or interesting. Instead, this discussion is meant as fodder for the construction of an integrative model of adoption that can address all the relevant attributes of pro-societal goods and similarly complex innovations. A major lesson from the popularity of DOI is that a simple, common language can enormously enhance the communicability and longevity of a research approach. In the next chapter, I develop a methodology to observe social influence within several social networks, which I will use to further assess the suitability of each of the five perspectives reviewed here, and to seek clues for a possible integration of these perspectives.

Table 4: Comparing alternative perspectives on interpersonal influence and adoption behavior

	Contagion		Conformity	Dissemination	Translation		Reflexivity
	Diffusion of innovations	**Social networks**	**Thresholds**	**Critical mass**	**Social construction**	**Actor-network theory**	**Modernity and self identity**
1. What is the innovation? (Static or dynamic?)	Innovation (static)	Innovation (static)	Behavior (static)	Collective good (static)	Artifact (dynamic)	Actor (highly dynamic)	Lifestyle practice (highly dynamic)
2. System boundaries? (Static or dynamic?)	Social system of potential adopters, the market (static)	Social network, typically a "bounded" community (static)	Relevant social group (static)	Social system, and critical mass (static)	Relevant social groups: e.g. consumers, organizations, government, etc. (dynamic)	All actors: including adopters, social groups, organizations, technology, etc. (highly dynamic)	Social system, lifestyle sectors, in context of modernity (highly dynamic)
3. Who adopts first?	Innovators and early adopters	The most "connected" individuals, opinion leaders	Instigators	Organizers	Social groups who perceive artifact as a solution to problem	Actors who view adoption as consistent with their "actor world"	Those who find practice is compatible with self concept
Why?	Higher "innovativeness"	More likely to receive info	Low threshold	High interest and resources	Interpretation of solution		Construction of self-identity
4. Who adopts later?	Imitators, early to late majority, laggards	Less "connected" invidiuals	Conservatives, due to high thresholds, social norms, or social learning effects	Non-organizers	Social groups that later reinterpret problems or solutions	Actors who are pulled into the "actor worlds" of others	Those who find practice is compatible with self concept
Why?	Lower "innovativeness"	Less likely to receive info	High threshold	Efforts of organizers and accelerating production function	Closure	Alignment	Search for self-identity
5. What drives adoption?	Contagion: interpersonal communication of information	Contagion: interpersonal communication of information	Conformity: motivation to mimic, learn from, or join others	Dissemination: willingness of organizers to achieve social good	Interpretation: perceived ability of innovation to solve a problem	Translation: perceived attributes can transform	Reflexivity: creating and sustaining self-identity
Best applied to what types of attributes?	Private-functional	Private-functional	Symbolic (private and societal)	Societal (functional and symbolic)	All	All	All

3 Methods: Mapping, Stimulating and Observing Social Networks

> *"Transport planning and even more so transport modeling has ignored the social dimension of travel in the past. There is therefore no empirical literature to fall back on."*
>
> \- Axhausen (2005, p100)

> *"By turning persons into research subjects with non-speaking parts in the script of social science, much investigation of interpersonal interaction can seem like an elaborate prologue to a play in which the characters are denied their lines."*
>
> \- Burnett (1991, p121)

In this chapter I explain the methods used to explore the role of social influence in vehicle purchase behavior. Axhausen's above quote echoes a theme that has flowed through the previous two chapters: very little research has explicitly explored the link between social processes and transportation decisions. Without theoretical or empirical precedent, there are few demonstrations of tractable methods that are appropriate for these efforts. Given this exploratory nature, this dissertation follows a *qualitative approach* to investigate the three research questions posed at the end of Chapter 1:

1. Does interpersonal influence play a significant role in the adoption of electric drive vehicles?
2. If so, how can we characterize the interpersonal processes that impact consumer perceptions of functional, symbolic and pro-societal attributes?
3. Under what social conditions might households adopt electric drive vehicles and the pro-societal car? (And how might policy create those social conditions?)

This research sought to observe individual consumers and households as they are embedded within their social networks. Interpersonal influence occurs, in part, via social interactions, i.e. verbal and non-verbal communication between individuals. Social interactions take place within social networks, which consist of multiple individuals connected by a wide variety of relationships, including family, friends, workmates, acquaintances and strangers. To study interpersonal influence, this methodology consists of four main components: i) mapping out the social networks of participating households, ii) stimulating the network through a multi-week trial and assessment of a plug-in hybrid electric vehicle (PHEV), iii) observing the social interactions and interpersonal influence that occur within the network pertaining to the PHEV, and iv) analyzing the observed social interactions.

The first section of this chapter outlines the appropriateness of a qualitative approach. The second section explains the study context: a PHEV demonstration project at the University of California, Davis. Third is an explanation of the recruitment of a subset of participants from this project, and fourth is an overview of the research design. The fifth section details each instrument used for this research, including an online questionnaire, ethnographic household interviews, and games to assist participants in the construction of social networks and the assessment of interpersonal influence. The final section details strategies followed to analyze the collected data.

3.1 Why follow a qualitative research approach?

I first distinguish between a *research approach*—the overall perspective and goals that guide the design of a research project—and specific *research methods*—the instruments employed to achieve such goals. Though the research approach for this dissertation is largely qualitative, the multi-method layout includes both qualitative and quantitative research instruments. In this section I further explain the differences between quantitative and qualitative approaches, and justify my selection of a qualitative approach for the present study context.

3.1.1 Comparing quantitative and qualitative approaches

McCracken (1988) identifies four key differences between quantitative and qualitative approaches to social research, according to: i) overall goals, ii) the relationships explored, iii) the complexity of collected data, and iv) sample requirements. First, the goal of *quantitative research* is to "isolate and define categories as precisely as possible before the study is undertaken, and then determine, again with great precision, the relationship between them" (McCracken, 1988, p16). Such research explores only one or a small set of relationships among variables, and relatively simple data is collected through closed-ended questions that respondents can respond to "readily and unambiguously" (p16). Further, quantitative researchers seek to "construct a 'sample' of the necessary size and type to generalize to the larger population" (p17). A quantitative approach may be most appropriate when testing hypotheses within a selected behavioral model, theory or perspective (Heffner, 2007).

In contrast, the goal of a *qualitative approach* is to "isolate and define categories during the process of research," where the researcher "expects the nature and definition of analytic categories to change in the course of the project" (McCracken, 1988, p16). Qualitative researchers allow for the discovery of "patterns of interrelationship between many categories rather then the sharply delineated relationship between a limited set of them" (p16). Qualitative data requirements are typically more ambiguous and demanding, where respondents must "labor to identify and articulate a response" (p16). Rather than focusing on the generalizability of the recruited sample, qualitative research seeks access to cultural categories, selecting less total respondents and working with each of them in more depth. While qualitative methods can be used to explore topics within a given behavioral perspective, the qualitative approach can also be used to challenge existing theories and develop new ones (Heffner, 2007).

Heffner (2007) asserts that quantitative and qualitative approaches pertain not only to what the researcher does, but also to their broader research paradigm. Quantitative research generally fits within the *positivist* paradigm, which believes in one true, universal reality which the researcher objectively "stands apart from" the subject and studies "without influencing the results" (Heffner, 2007, p96). This paradigm explains the focus on objective, controlled experiments and the assessment of study quality according to metrics of "internal validity, external validity, reliability and objectivity" (Heffner, 2007, p96). In contrast, a qualitative approach fits the *interpretivist* paradigm, which "acknowledges that people can view the same world in very different ways," where reality is "socially constructed" (Heffner, 2007, p98). Researchers immerse themselves into this reality in order to study it, inevitably influencing the subject and working with them to develop results. Such a paradigm is more amenable to the use of qualitative research methods like interviews and focus-groups—allowing for more depth and exploration through open-ended questions than would be used in quantitative research instruments like surveys.

To illustrate these differences, consider a hypothetical example where I investigate the role of environmental values in the purchase of hybrid-electric vehicles (HEVs). Following a quantitative research approach, my goal is to test my hypothesis that pro-environmental values increase the likelihood of HEV purchase. I might design a questionnaire with close-ended questions eliciting several discrete categories of environmentalism (e.g. high, medium, low) and recent vehicle purchase details, and administer the survey to representative sample of U.S. car buyers. Lastly, I would perform statistical analysis on the results (controlling for potential confounding factors) to test my hypotheses of causality.

A qualitative research approach would flow much differently. Rather than a quantifiable hypothesis, I might start with an exploratory research question, such as "what motivates HEV purchase behavior?" I might engage a small sample of U.S. car buyers in in-depth interviews, posing open-ended questions about why they bought the vehicles they did, as well as eliciting views on environmentalism. Content analysis across responses could yield themes that indicate a more appropriate conceptualization of environmentalism than the “high,” “low” and “non-existent” categories I assume above. Open-ended questions also allow respondents to describe a wide array of motivations regarding their purchase, such as the pressures of a car dealer, or input from a relative who recently bought a similar vehicle—contextual features that would be missed in closed-ended questions. Further, this approach would allow more flexible exploration of causality, including the ability to turn causation around—did the purchase itself influence the individual’s perception of their environmental values? Results could yield new themes and help revise or develop theories of vehicle purchase behavior.

McCracken points out that “qualitative and quantitative approaches are never substitutes for one another…they observe different realities, or different aspects of the same reality” (1988, p18). For this reason, I do not frame this dissertation exclusively from the qualitative approach or interpretivist paradigm—I also consider the quantitative perspective where helpful. However, I do primarily rely on qualitative methods, which I justify according to the context (assessment of new vehicle technology) and purpose (understanding processes of social influence) of this study.

3.1.2 Vehicle purchase behavior and the qualitative approach

Heffner (2007) discusses how the majority of transportation and vehicle purchase research utilizes quantitative research methods flowing from the positivist research paradigm. As noted in Chapter 2, the dominant behavioral model in transportation behavior is rational choice, which is almost ubiquitously quantitative in application. Rational choice researchers exploring “stated preferences” administer sets of pre-defined choice categories to large, representative samples to elicit consumer responses and statistically estimate causal relationships (e.g. Bunch, et al., 1993; Ewing and Sarigollu, 2000; Potoglou and Kanaroglou, 2007). From the even more positivistic perspective of conventional economics, *stated preference methods* are not objective enough. Thus, *revealed preference* research is employed to avoid or mitigate consumer bias—analyzing actual purchase behavior or market data rather than rely only on hypothetical responses (e.g. Brownstone, et al., 2000; Train, 1980).

As noted above, the quantitative approach is most appropriate when a researcher is testing hypotheses within a selected behavioral model or perspective, such as the rational choice. However, the quantitative approach does not aptly identify or characterize behavioral processes that prove inconsistent with the selected model. In contrast, a qualitative approach can be used to “highlight deficiencies upon which choice models are built” (Heffner, 2007, p89)—as well as explore a range of other behavioral models and perspectives. Unfortunately, when qualitative methods are used in transportation research, they are typically implemented in tandem with quantitative methods, where the quantitative portion of the study is perceived to yield the “real results” (Heffner, 2007). For instance, qualitative focus groups and interviews may be employed only as a precursor or pre-test to a quantitative phase, such as a large-sample questionnaire (e.g. Ewing and Sarigollu, 2000; Graham, et al., 2001). Despite such tendencies, qualitative methods can stand on their own, and when used properly can yield more useful and appropriate results than quantitative approaches. For example, Kurani and Turrentine's (2007) semi-structured interviews of car buyers discovered that consumers could not evaluate vehicle fuel economy in a rational way—a finding that contradicts some of the most basic assumptions of the models used by most researchers of vehicle purchase behavior.

There are two major reasons why the vehicle technology context of this study warrants a qualitative approach. The first is that the common behavioral models of vehicle purchase behavior, e.g. rational choice, require revision to better account for the various mechanisms that may underlie vehicle purchase behavior—particularly processes of social influence. A quantitative approach would not allow me to challenge current conceptualizations and explore alternative cultural categories.

The second is that I am studying an emerging vehicle technology which has had little market exposure. The highly ambiguous and complex nature of plug-in hybrid vehicles (PHEVs) creates difficulty in eliciting meaningful, reliable responses and interpretations via quantitative methods alone. As noted in Chapter 2, qualitative research indicates that consumer preferences for EVs and other alternative fuel vehicles may be non-existent or unstable—and are typically formed by participants as they respond to research questions (e.g. Turrentine, et al., 1992). Heffner et al. (2007) found that in-depth ethnographic interviews effectively elicited the complex symbolic meanings HEV buyers associated with their vehicles. And as described in Chapter 1, recent research indicates that PHEV technology may have be particularly unknown in the market—U.S. car buyers have little pre-existing awareness or understanding of what a PHEV is or should be (Axsen and Kurani, 2008). Thus, a purely quantitative approach would likely miss the complexity and uncertainty of consumer evaluations of PHEV technology.

3.1.3 Social influence research and the qualitative approach

The quantitative approach is also favored in most research on social influence in non-transportation applications. Social network analysis has proved a particularly popular methodology, where researchers represent individuals and the relationships among them with complex quantitative metrics and look for statistical patterns that link aspects of social ties with observed outcomes. When representing a social network, researchers “invent graph-theoretic properties that characterize structures, positions, and dyadic properties (such as the cohesion or connectedness of the structure) and the overall ‘shape’ (i.e., distribution) of ties” (Borgatti, et al., 2009, p894). Such quantitative approaches have also prevailed among the few applications of social influence in transportation applications (e.g. Arentze and Timmermans, 2008; Carrasco and Miller, 2009; Carrasco and Miller, 2006).

As with transportation research, the pervasiveness of the quantitative approach in social influence research stems from a positivist tradition. Researchers try to infer the occurrence of social influence from observed behavior, rather than observe the interactions directly (Manski, 2000). Manski (2000, p131) explains how economists (coming from a discipline that espouses positivism) researching social influence are "deeply skeptical of subjective statements" because they are trained to "believe only what people do, not what they say…[that] there is no reason to believe that subjective responses reliably reflect respondents' thinking." Without data directly representing social interactions, researchers "have compensated by imposing assumptions" (Manski, 2000, p131).

However, the quantitative approach to social influence research yields empirical and theoretical limitations. Manski (2000, p117) notes that there is "inherent difficulty" in relying only on observed outcomes because such outcomes "can usually be generated by many different interaction processes, or perhaps by processes acting on individuals in isolation…the findings of empirical studies are often open to an uncomfortably wide range of interpretations." To help sort through different explanations of empirical outcomes, Manski (2000, p127) distinguishes the *endogenous interactions* that are indeed processes of social influence from the *contextual interactions* (e.g. socioeconomic factors) and *correlated effects* (e.g. effects common to the entire group) that are not. An inability to parse out these different effects results in what Manski (2000, p128) calls the *reflection problem*: where "data on outcomes do not reveal whether group behavior actually affects individual behavior, or group behavior is simply the aggregation of individual behaviors."

For example, Christakis and Fowler (2007) published a study using 32 years of social network data from over 12,000 participants in the Framingham Heart study, suggesting that obesity is in part caused by processes of interpersonal influence. Such groundbreaking results gained substantial media attention (e.g. Thompson, 2009). Yet Cohen-Cole and Fletcher (2008a) analyzed similar data and discovered that once environmental factors, i.e. Manski's correlated effects, are controlled for, Christakis and Fowler's supposed endogenous interactions become statistically insignificant. In another study, Cohen-Cole and Fletcher (2008b) further illustrate how inattention to environmental factors can falsely indicate that endogenous interactions cause acne, height and other implausible phenomena. Considering such challenges with confounding factors and data difficulties, Valente (2005) states the larger-scale survey methods used to gather data may not yield sufficient insights into the role of social forces. Chapter 2 summarized his example of a famous social network study (Coleman, et al., 1957), where initial results suggesting the importance of social influence were later invalidated when external events were accounted for.

Even when endogenous interaction effects can be empirically isolated and identified, their quantification does not shed light on the underlying processes of social influence (Manski, 2000). In fact, positivist researchers rarely consider theories of social influence in any depth, instead loosely tying their study design to one of the "abundance of concepts" (Manski, 2000, p121) borrowed from sociology, such as "'peer influences,' "neighborhood effects," "social capital,' or some other concept" (p117) which are used interchangeably across the literature. Similarly, Borgatti et al.'s (2009, p894-5) review of social network analysis conceptualizes the different "theoretical mechanisms" of social influence using terms such as "direct transmission," "adaptation," "binding," and “exclusion”—terms borrowed from the physical sciences of epidemiology, biology, chemistry, and physics. However, as noted in Chapter 2, there are at least five different behavioral perspectives on the role of social influence, which I call contagion, conformity, dissemination, translation and reflexivity—the comparison of which is generally omitted from quantitative research approaches. The exploration and comparison of these differing perspectives is a major justification of the qualitative approach used in this study. The intent is to use empirical data to test, and potentially synthesis, these perspectives.

Given the dearth of insight into the mechanisms of social influence, Manski (2000, p131) asks: “why not elicit them directly” from respondents? Manski explains that the positivist resistance to subjective exploration is “unfounded” (p132), where researchers require “richer data” than that used to date (p133). Along these lines, Geertz (1973) explains the importance of eliciting *thick description* in behavioral research, accounting for the context of observed behavior by recruiting the participant as expert and storyteller to explain the role of social influence in these events (as opposed to *thin description* without context). The potential for bias inherent in subjective data collection may actually be a strength, where in behavioral research it is often more useful “to measure a person’s perception of their world than to measure their actual world” (Borgatti, et al., 2009, p895). And while the participant may “have difficulty giving the full account of what they believe and what they do,” careful method design can assist them in this task (McCracken, 1988, p23), as further explained in this chapter.

A final reason for the qualitative approach followed in this study is the uncertainty surrounding a social network as a unit of analysis. The process of appropriately defining and mapping a social network is in its infancy. For starters, "there is no single social network in a community that serves all purposes…different innovations engage different networks" (Bandura, 2006, p123). Networks can be based on location, group membership, common attributes, kinship, roles, affection, cognition, interaction pattern, or flows of information, beliefs or resources (Borgatti, et al., 2009), and networks can change over time (Feld, et al., 2007). The present study in part seeks to identify which aspects of a personal network can be stimulated by electric-drive and pro-societal cars—something that would be very difficult to accomplish with a quantitative survey.

3.2 Study context: The UC Davis PHEV demonstration project

Because PHEVs are not yet offered for sale in the U.S. auto market, it is not currently possible to observe PHEV purchase behavior. There exists a handful HEV owners who have converted their HEVs to a PHEV, most of whom are electric-drive enthusiasts that are unlikely to represent the breadth of a plausible early PHEV market (Heffner, et al., 2009). In place of PHEV purchase behavior, in this study I observe consumer assessment of PHEV technology within the context of a PHEV demonstration project conducted by the Plug-in Hybrid Electric Vehicle Research Center (PHEV Center) at the University of California, Davis. The full demonstration project is detailed by Kurani et al. (2009b).

With funding from the CARB's Alternative Fuels Implementation Program, the PHEV Center converted 12 Toyota Priuses to PHEVs using the Hymotion (now A123Systems) conversion package. For each Pruis, a 5 kWh lithium-ion battery was installed into the spare tire well and integrated with existing software and hardware systems to allow the battery to be recharged and to help power the drivetrain. The result is a fleet of vehicles capable of about 30 miles of blended charge-depleting operation, or B-30s (using terminology introduced in Section 1.2). Each converted PHEV Prius is equipped to record driving, recharging and energy use data and transmit it to be recorded and portrayed on a website by V2Green Inc. (now Gridpoint, Inc.).

As of March 2010, the PHEV-conversions have been successfully placed into 67 households in the Sacramento region for four to six weeks trials.[7] Participating households are from a sampling frame of American Automobile Association (AAA) members recruited for the PHEV household demo study at UC Davis.[8] The geographic distribution of the complete sample is depicted in Figure 13. Data were collected from the vehicles data collection systems, from in-person interviews, on-line questionnaires, and fueling logs. The overall demonstration project undertook several research activities:

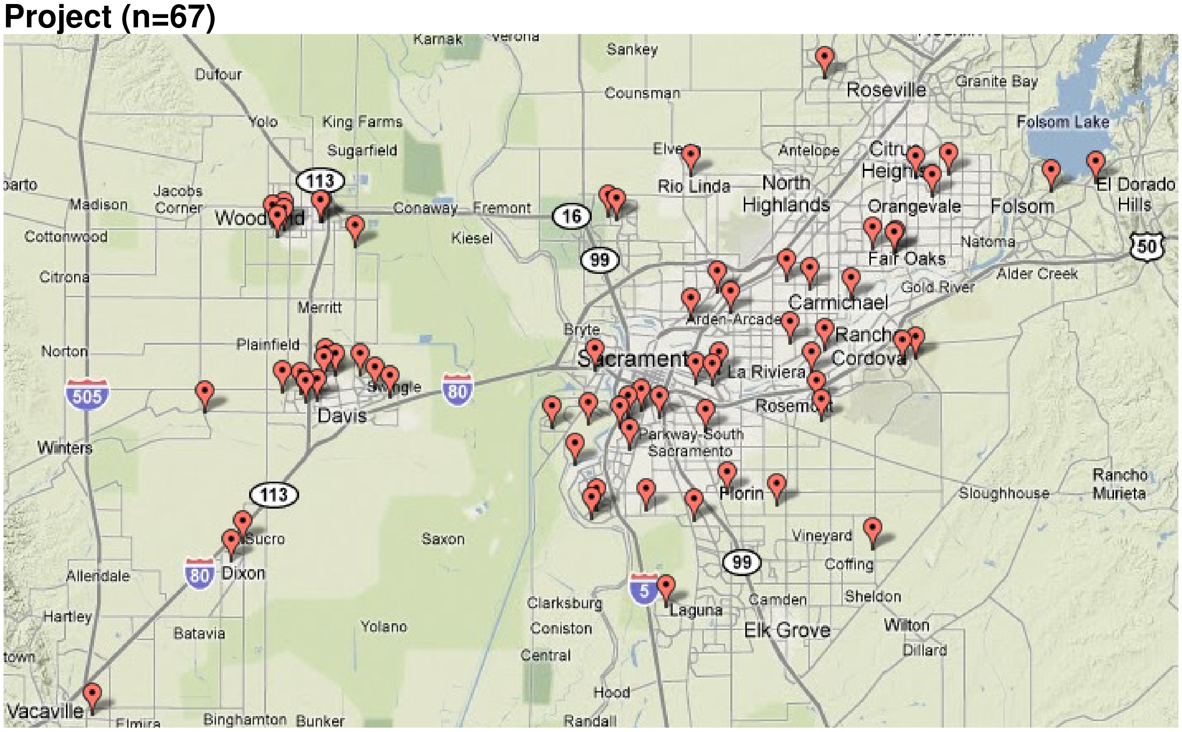
---

[7] Households completing a six week trial were given a PHEV with the extra battery disabled for the first two weeks—the vehicle would function as a conventional HEV Prius during this time. After two weeks, researchers then activated the extra battery so the vehicle would perform as a PHEV for the remaining four weeks. Households completing a four week trial were given a PHEV with the battery activated from the the beginning. The addition or omission of the two week HEV trial did not appear to make an important difference within the context of this dissertation, so I do not discuss it further and simply refer to the trial as "four to six weeks."

[8] AAA is a partner with UC Davis in the PHEV household demo project; only AAA members are permitted to take part in the demo.

1. *Household response to the vehicles*: including PHEV design interests, recharging behavior and energy use.
2. *Narratives*: a methodology employed to “tell the best possible story about each household and their experience with PHEVs” (Kurani, et al., 2009a, p.iii).
3. *Interfaces and instrumentation*: household response to the Toyota Prius Energy Monitor and Fuel Consumption displays, the V2Green website, and a custom-made driver feedback display.
4. *Social influence*: conducting the research reported in this dissertation, focusing on a subset of 10 participating households from the overall demonstration project, and their personal networks.

Figure 13: Participating households in the UC Davis PHEV Demonstration Project (n=67)



The remainder of this dissertation focuses on the fourth research activity, but the methodology benefited from the data collection methods employed for other activities, i.e. on-board vehicle data collection, on-line questionnaires and narrative construction—each of which served to increase understanding regarding participating household's demonstration experience, assessment of the PHEV, and patterns of social influence.

3.3 Selecting participants and their personal networks

In this study I seek to observe social influence by observing the social networks of car buyers rather than focusing only on car buyers themselves. Social network literature differentiates between analyses at the *total network* level versus those at the *personal network* (or egocentric network) level. A *total network* accounts for every link among all individuals in a given social system. Such an approach is feasible when researching a narrowly defined or bounded social network, such as mapping out relationships among employees at a small company, or residents in a particular community. However, in most situations it is only feasible to collect data from different personal networks (Carrasco, et al., 2008; Degenne and Forse, 1994)—particularly when considering the broad, disparate nature of California car buyers and the people that might influence or be influenced by them. A *personal network* is represented by: i) a primary individual or household (the *ego*), ii) the other individuals they are socially connected to (the *alters*), and iii) characterizations of the relationships, or ties, between all these individuals (Carrasco, et al., 2008).

In a sense, a personal network is a sample from a total network; with enough personal networks mapped out for a given social system, a researcher might be able to construct the total network. However, the primary goal in the present study is not to construct a total network, but rather to map out enough of a given PHEV demonstration participant's personal network to permit the observation of social interactions and influence pertaining to the vehicle. To do this, I recruited a subsample of participants from the UC Davis PHEV demonstration project—each participating household in this subsample is a *primary household* that constructs their personal network as part of this project. Each individual they identify in their personal network is an *alter*. For each primary household, I also try to recruit one or more alters to participate in this study through a form of snowball sampling (Schutt, 2004). Successfully recruited alters are called *secondary participants*.

To explore my stated research questions, I study several personal networks in-depth rather than seeking a representative sample. In a qualitative research approach, "less is more" when it comes to sample size (McCracken, 1988, p113), where samples often range from five to 25 individuals (Kvale, 1996). Following a technique common to qualitative research, the number of primary households in this study was set to expand until additional interviews no longer yielded new findings (Schutt, 2004). Although an individual's total list of social alters could be in the hundreds or thousands, other researchers estimate that most individuals have five to 15 people they would consider to be socially close, with three to five identified as a central referent group (Axhausen, 2008; Zhou, et al., 2005). In one study, Hogan et al. (2007) found that eliciting "somewhat close" as well as "very close" alters yielded personal networks with an average of 24 alters—though many had less than 16, and others had more than 65. Because there can be drawbacks to constraining network size (Marsden, 1990), such as neglecting relatively weak ties that can prove particularly influential in certain circumstances (Granovetter, 1973; Hogan, et al., 2007), in this study I sought to map out as much of a primary household's social network as could feasibly be done. Thus, in addition to identifying socially close alters, I also asked primary households to identify somewhat close alters (using Hogan et al.'s (2007) definition described below), and to account for unanticipated interactions with more socially distant alters (casual acquaintances and strangers) that may arise during their PHEV trial.

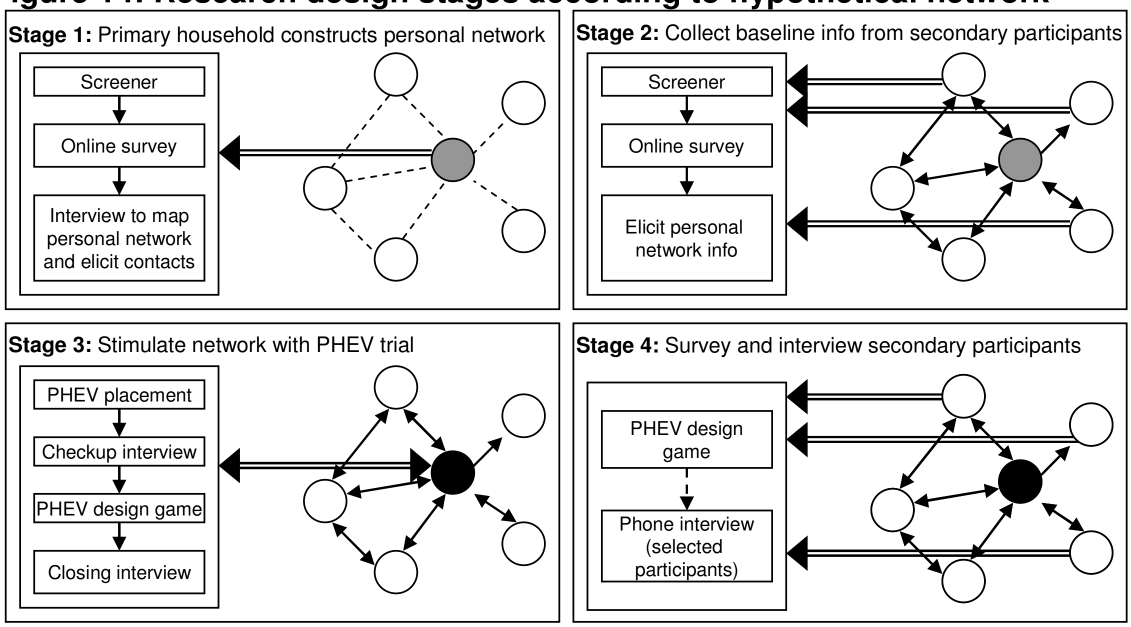
While I do not seek to produce a representative sample of U.S. car buyers in the quantitative sense, this study attempts to include participants from a breadth of backgrounds and lifestyle practices. For instance, Turrentine and Kurani's (2007) interviews of car buyers and fuel economy intentionally sampled households from nine "illustrative sectors…defined by economic, lifestyle, and knowledge considerations, for which we had simple hunches about their potential choices and values" (p1217), including: nearly or recently graduated colleges students, off-road vehicle users, state resource agency employees, farmers and ranchers, computer engineers, military households, financial service workers, outdoor recreationists, and HEV buyers. While the present study does not seek such an extensive diversity of sectors, I do target a breadth in age, income, household size, employment categories, environmental values and familiarity with electric-drive vehicles. Chapter 4 describes characteristics of the resulting sample of primary households and secondary participants.

3.4 Overview of research design

Given the exploratory nature of my research questions, this study followed a “multi-method” approach (McCracken, 1988, p28) to collect data from numerous perspectives. Research instruments included: multiple *interviews* with structured and ethnographic components, a *social network mapping game*, a *social episode diary*, an *influence ranking game*, and a multi-part online *questionnaire*. This section details the flow of these various methods, while the next section details the specific instruments. Interviews were the primary means of contact with primary households; other instruments, some of which were more quantitative in nature, primarily served to help structure and stimulate participant reflection and discussion in the interviews. Quantitative instruments also facilitate comparison of demographic and other descriptive characteristics across PHEV demo participants and to the distributions of other study samples.

Figure 14 illustrates the employed study design according to one hypothetical network, while Figure 15 depicts the timeline as experienced by a hypothetical primary household and secondary participant. Figure 15 also highlights how the study design for both the primary household and secondary participants was constructed to elicit their overall assessment of the PHEV technology (red rectangle) after exposure to the PHEV demonstration. The research design allows me to explore the role that observed social interactions played in these assessments—thus exploring patterns of social influence relating to vehicle assessment as a form of vehicle purchase behavior. The four stages of Figure 14 were implemented as follows:

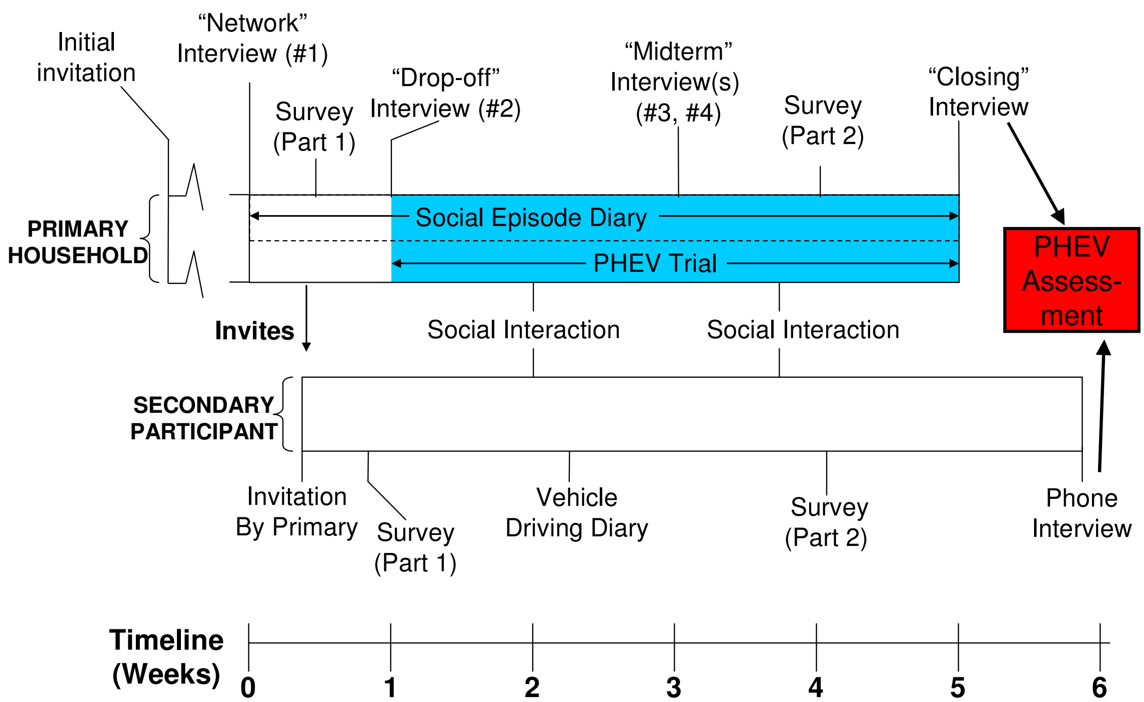
Figure 14: Research design stages according to hypothetical network



3.4.1 Stage 1: Contact primary household and elicit personal network

As with all participants in the UC Davis Demonstration project, initial contact was made with the primary household through an internet-based questionnaire to screen for eligibility, i.e. determining that the household owned and operated a vehicle, they lived within the Sacramento region, and they had appropriate AAA membership. After a researcher recruited the qualifying household by phone, the researcher then visited the primary household to complete interview #1 (Appendix A), which covered the following topics:

Figure 15: Approximate timeline of research design (for a hypothetical primary household and secondary participant)



1. *Overview of the study:* assessing the primary household's ability to recharge a vehicle, i.e. the presence of a grounded electrical outlet, explaining research components and participant rights and signing participant agreements.
2. *Household vehicle purchase history:* eliciting primary household's narratives of the vehicles they currently own and previously owned, including the perceived benefits and drawbacks of each (adapted from Heffner, 2007).
3. *Future vehicle purchase intention:* eliciting information about potential future plans to purchase a new vehicle, including the primary objectives of purchase and any specific models that are being considered.

4. *Personal network mapping:* identifying a core network of *very close* and *somewhat close* alters, with prompts of several potential categories, including experts (e.g. those they would typically consult for the purchase of a vehicle, technology or device), dependents (e.g. those that would consult them), as well as close friends and frequent contacts.
5. *Instructions to recruit secondary participants:* primary households were then instructed to personally invite several alters to the study by phone, email, or personal contact. Secondary participants were promised monetary rewards. To encourage follow-through, primary households were asked to identify five to 10 alters they would invite within the following week.
6. *Social-episode diary:* providing a booklet and instructing primary households to make brief notes of any social interactions in which they discuss PHEVs, electric drive, or vehicle purchases in general over the four to six-week period of the PHEV trial in Stage 3.

3.4.2 Stage 2: Collect baseline information from secondary participants

Next, primary households were given a week to recruit secondary participants. Primary households and recruited secondary participants were all requested to complete an online questionnaire before the PHEV trial began (Appendix B). The survey for secondary participants was nearly identical to that for primary participants, but with the addition of questions asked to confirm their social proximity with the primary household (Appendix K).

3.4.3 Stage 3: Stimulate personal network with PHEV trial

In interview #2, researchers returned to commence the primary household's four to six week PHEV trial. The primary household was given brief explanation of the PHEV and a test drive, and asked to provide an describe and discuss their social interactions. The household was asked to substitute the PHEV for one of their vehicles and thus integrate it into their lifestyle for the duration of their trial. During their trial, the household completed several tasks, including:

1. The social episode diary (Appendix F).
2. An online PHEV design questionnaire (survey Part 2, Appendix H).
3. One or two midterm interview (every two weeks), including a technical check up, informal questioning, and verbal updates of social episodes from their diary.
4. A closing interview (Appendix I), consisting of questions regarding:
    a. The household's overall experience with the PHEV (narrative).
    b. Recharging, driving, and fueling behavior.
    c. The participant's overall assessment of the PHEV, including functional, symbolic and pro-societal interpretations, and the dynamics of these interpretations over the course of their trial.
    d. Assessment of interests in future vehicle purchases (assisted by previously elicited responses in the PHEV design questionnaire).
    e. Social episodes with members of the personal network (and others) including the content and frequency and perceived importance of such discussions.

f. Ranking the influence of each social, technical and research experience (defined below) regarding their assessment of the vehicle technology.

3.4.4 Stage 4: Network questionnaire and selected interviews

At the close of the trial, secondary participants were again contacted to share their observations of the primary household's PHEV trial, and personal interpretations and assessment of the PHEV technology. 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 final 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 (Appendix L).

3.5 Research instruments

This section further details each of the research instruments used within the study design outlined above. These instruments include the online PHEV questionnaire, sociogram construction tool, recruitment of secondary participants, social episode diary, influence ranking exercise, and finally, the semi-structured interviews that help pull together much of the information collected by these instruments.

3.5.1 On-line PHEV questionnaire

Primary households

In addition to the initial screening questionnaire, each primary household also completed a two-part online survey eliciting several types of data. One purpose of this survey was to help elicit the household's assessment of the PHEV technology. The survey was slightly modified from the instrument administered to over 2,200 U.S. respondents as reported in Axsen and Kurani (2008), and briefly summarized in Section 1.3. This previous study included over-samples of California (n= 851) and Northern California (n=216) in the region along Interstate-80 from the San Francisco Bay Area to the eastern reaches of the Sacramento area. To help characterize the present qualitative sample, Chapter 4 compares primary household and secondary participant responses to these previous survey respondents from the representative, California statewide subsample

The survey instrument includes two internet-based questionnaires, each requiring 20 to 30 minutes to complete, eliciting participant: i) background information, completed before the household drives the PHEV, and ii) plug-in hybrid electric vehicle (PHEV) design interests, completed after the household has driven the PHEV for several weeks. Part one includes questions on vehicle ownership, knowledge of gasoline and electricity use and spending, awareness of electric-drive vehicles, attitudes towards environmental and global issues, as well as household structure, income, education and other demographic variables (Appendix B). Awareness of electric-drive vehicles is assessed with questions eliciting the stated familiarity of respondents with conventional gasoline vehicles, HEVs, EVs, and PHEVs. Respondents were then asked to demonstrate their understanding by indicating how each vehicle type could be fueled: with gasoline, electricity through an electrical outlet, or either. The implication of this exercise is not that consumers need to have a deep technological understanding of electric-drive vehicles in order to buy them. However, basic prior familiarity, i.e. whether or not the vehicle can be plugged in, may shape participants experience with the PHEV-conversion during their trial period and ultimately affect their PHEV design priorities.

Part two of the survey focuses on PHEV design priorities elicited in two versions of *priority-evaluator games* (Appendix H). In Chapter 2 I explain that previous alternative fuel vehicle research typically infers consumer preferences for vehicle attributes by presenting participants with a description of one or several new technologies, followed with a set of hypothetical choice scenarios in which respondents choose from sets of vehicles of different attributes. However, such methods may not capture the complexity of vehicle purchase behavior, particularly regarding unfamiliar vehicle technologies. Constructive design processes, such as the design games used in this study, are consistent with theories of constructed preferences that view consumer preferences as outcomes of, not inputs to, decision contexts and processes (Bettman, et al., 1998). To improve the quality of data gathered from participants, prior to the PHEV design exercises, participants were provided a PHEV buyers' guide describing basic design options for PHEVs (replicated in Appendix G). Respondents then completed two PHEV design games. The first was a *PHEV Development Priority game* in which participants created PHEV designs over several iterations. Second was a *Purchase Design game*, similar to the first, but the design possibilities were priced in dollars and participants could reject buying a PHEV, retaining a conventional vehicle.

Both games focused on four PHEV design attributes (see Section 1.2 for details of PHEV technology): i) hours required for complete recharge of a depleted battery, ii) gasoline use in *charge depleting* (CD) mode, iii) miles of range in CD mode, and iv) gasoline use in *charge sustaining* (CS) mode. In each game, a base PHEV design is offered with capabilities easily achievable by current battery technology (Axsen, et al., 2008): a PHEV that requires up to eight hours to completely recharge, that can be driven for the first 10 miles in CD mode using blended operation that increases gasoline-only fuel economy to 75 mpg, and that can improve fuel economy by 10 mpg when operating in CS mode over an otherwise similar conventional internal combustion engine vehicle.[9] In both games, participants were given opportunities to improve each attribute under different resource conditions.

The first exercise, the *Development Priority game*, presents participants with a hypothetical scenario: an existing household vehicle is to be upgraded to a PHEV at no cost.[10] The performance and appearance of their vehicle would remain the same, except for the additional plug-in hybrid capabilities. Participants were presented with a base PHEV model and given points they must allocate among potential upgrades. Over five

---

[9] Note that these PHEV design games are meant to represent a PHEV design space that is technologically feasible and that allows respondents to tell us which (and how much) of the four attributes are more or less important, but not necessarily to produce precise vehicle specifications. For instance, the battery required for our base PHEV design would likely require only 2 to 3 hours to fully recharge with a 110-volt circuit. However, based on pre-testing, we chose to simplify attribute levels and ignore potential interactions to create exercises that are more likely to be understood by our respondents.

[10] Which household vehicle was to be upgraded was determined in Part One of the survey as either the vehicle that the household most recently purchased, or, the newer vehicle that is most frequently driven.

rounds of the Development Priority game, participants were provided progressively more points (Table 5). For the first three rounds of the game higher levels of upgrades of the four attributes and more combinations of upgrades were also offered, expanding the PHEV design envelope to observe participants' allocation of resources. A screenshot of the game, along with the language used for respondents, is portrayed in Appendix H.

Table 5: Upgrades for PHEV Development Priority game

Attribute (base value)	Round One: (1 point)	Round Two: (2 points)	Rounds Three, Four and Five: (4, 6 and 8 points)
Recharge time: (8 hours)	4 hours (1pt)	4 hours (1pt) 2 hours (2pt)	4 hours (1pt) 2 hours (2pt) 1 hour (3pt)
Charge depleting (CD) mpg and type : (75 mpg)	100 mpg (1pt)	100 mpg (1pt) 125 mpg (2pt)	100 mpg (1pt) 125 mpg (2pt) All-electric (4pt)
CD range: (10 miles)	20 miles (1pt)	20 miles (1pt) 40 miles (2pt)	20 miles (1pt) 40 miles (2pt)
Charge sustaining (CS) mpg: (Current mpg* +10)	Current mpg +20 (1pt)	Current mpg +20 (1pt) Current mpg +30 (2pt)	Current mpg +20 (1pt) Current mpg +30 (2pt)

The second exercise, the *Purchase Design game*, framed the PHEV design exercise in the context of a future vehicle purchase. The questionnaire first elicited information about the anticipated price, make, and model of the next new vehicle the respondent's household would likely buy. The respondent then completed two PHEV purchase exercises, each comparing their anticipated conventional vehicle with a PHEV version of the same. Participants were presented with a "higher" price and "lower" price PHEV purchase conditions, where prices in both conditions also depended on whether the vehicle was a car or truck (Table 6). As in the Development Priority game, each exercise started with the same base PHEV model, with additional upgrades available for added price. The participant could choose either their anticipated conventional vehicle, the offered (base)

PHEV, or to upgrade the PHEV. A screenshot of this exercise is portrayed in Appendix H. As explained further in Axsen and Kurani (2008), upgrade prices in Table 6 are largely hypothetical, though they do approximate price estimates from previous studies (e.g. Duvall, et al., 2002; Kalhammer, et al., 2007; Markel, et al., 2006).

Table 6: Price of upgrades for Purchase Design game

Attributes (base level)	Attribute level	"High" price Car	"High" price Truck	"Low" price Car	"Low" price Truck
Base premium		$3,000	$4,000	$2,000	$3,000
Recharge time (8 hours)	4 hours	+$500	+$1,000	+$250	+$500
	2 hours	+$1,000	+$2,000	+$500	+$1,000
	1 hour	+$1,500	+$3,000	+$750	+$1,500
CD mpg and type (75 mpg)	100 mpg	+$1,000	+$2,000	+$500	+$1,000
	125 mpg	+$2,000	+$4,000	+$1,000	+$2,000
	All-electric	+$4,000	+$8,000	+$2,000	+$4,000
CD range (10 miles)	20 miles	+$2,000	+$4,000	+$1,000	+$2,000
	40 miles	+$4,000	+$8,000	+$2,000	+$4,000
CS mpg (Current mpg +10)	Current mpg +20	+$500	+$1,000	+$250	+$500
	Current mpg +30	+$1,000	+$2,000	+$500	+$1,000

Secondary participants

Secondary participants completed the same online survey as primary households, but with two important additions. First, between parts one and two of the online diary, respondents completed a *Plug-in Potential diary* of driving and parking for one of their new vehicles. The main purpose of this exercise was to help inform secondary participants about how they might use a PHEV—primary households did not need this exercise because they had several weeks to drive and plug-in a real PHEV. Secondary participants were assigned a day of the week and instructed to record information for a 24-hour period starting with their first trip of the day. Information included the timing and distance of each trip, parking locations, and the proximity of those locations to an electrical outlet. Respondents recorded data in a diary printed from a PDF document and then input the data online using an online instrument. The respondent's diary day was immediately depicted to them as a graph, using a technique similar to that used by Kurani et al. (1994; 1996) to help respondents better understand their own driving behavior and how an electric-drive vehicle could fit into their lifestyle.

Secondly, the survey for secondary participants also added questions about social interactions to help researchers determine if they should interview the secondary participant (Appendix K). A section was added to the beginning of part one of the online survey, asking questions to confirm the name of the primary household member that recruited them, their social proximity, the nature of their relationship, by what form of communication the recruitment took place, and a summary of what was discussed. Another section was added to the end of part two that solicited information about any social episodes that took place with the primary household, including how many times they have been in contact with the primary, what forms of communication where used, how often the PHEV was mentioned (if at all), what the secondary participant asked about the PHEV (if anything), what the primary household told them about the PHEV (if anything), what the secondary learned overall, and how influential these social interactions were over the secondary participant's assessment of the PHEV.

3.5.2 Constructing personal social networks (sociograms)

Eliciting personal network data from an individual or household can be very challenging, including efforts to scope network size, overcome limitations in respondent recall, and mitigate respondent burden (Carrasco, et al., 2008; Marsden, 1990). A *sociogram* can represent relationships in many different ways; interpersonal ties can be determined by individual evaluations of friendship and respect, associations (e.g. club membership), behavioral interaction (e.g. frequency of talking or playing sports), physical connections (e.g. neighborhood), formal relations (e.g. authority), biological relation (Wasserman and Faust, 1994), or, with respect to diffusion research, by directly "asking respondents whom they sought (or hypothetically might seek) for information about a given topic, such as a particular innovation" (Rogers, 2003). Also, an individual's elicited personal network may be inaccurate. Typically, the primary individual's reports are not tested by contacting other identified network members (Carrasco, et al., 2008), and when they are, rates of corroboration can be low (Marsden, 1990). Further, it may be difficult to forecast which alters may be influential in a new context, e.g. assessing an electric-drive vehicle, based only on past experience.

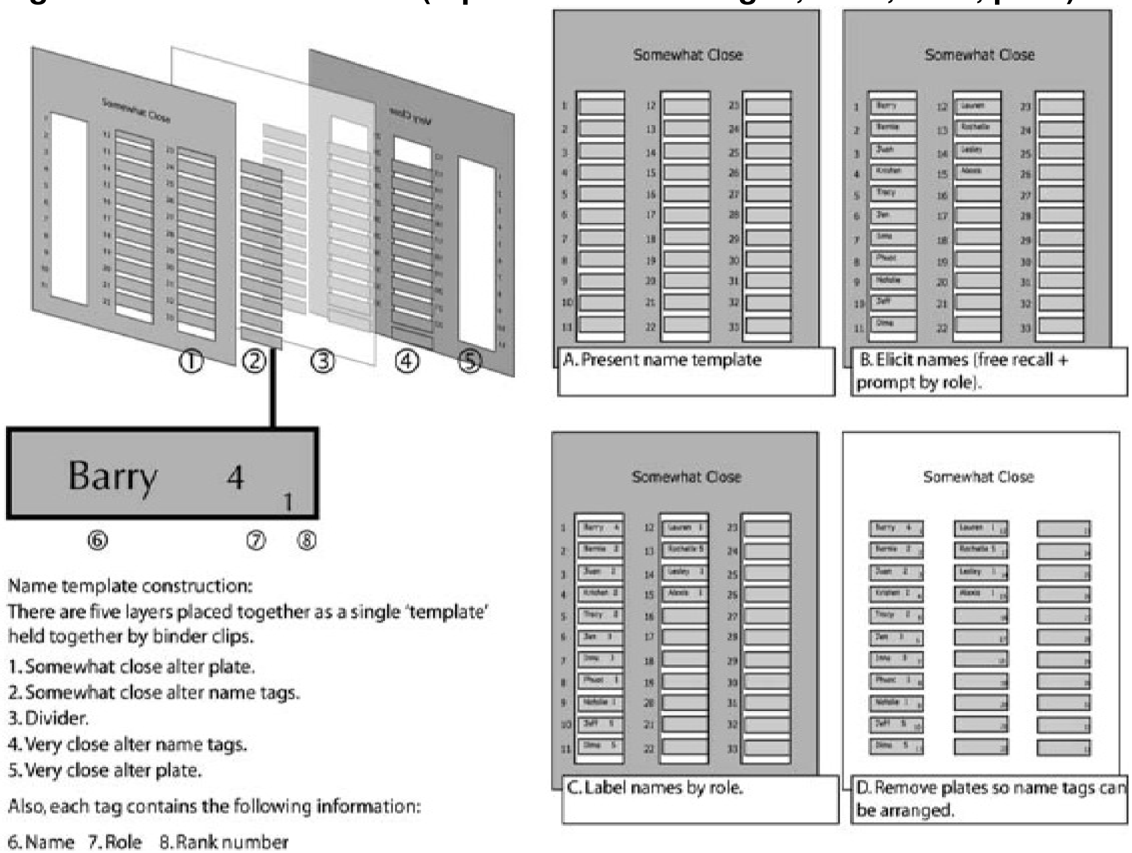
In this study, I borrow from a technique outlined by Hogan et al. (2007) to assist primary households in the creation of their sociogram. Their approach provides a clear structure with discrete steps. Such a technique can be categorized as a form of "personal network visualization," which has been found to produce more accurate and useful data than eliciting freestyle drawings from participants (McCarty, et al., 2007). My adaptation consists of three stages: name generation, construction of the sociogram, and identification of vehicle-related alters (interview questionnaire is depicted in Appendix A).

First, *name generation* is a common method of eliciting a list of alters, although techniques vary; questions can be framed by identifying individuals that "you discussed matters most important to you" (Burt, 1997) or "you ask for help to discuss personal problems with" (Axhausen, 2008), or with more specific, hypothetical conditions such as who would lend you money or babysit your children (Hogan, et al., 2007). Hogan et al.'s technique (2007, p123) focuses on social proximity, first asking respondents to generate a list of two types of alters using intentionally open-ended definitions:

- **Very close**: people that you "discuss important matter with, or regularly keep in touch with, or are there for you if you need help."
- **Somewhat close**: people that are "more than just casual acquaintances, but not 'very close.'"

Primary households were asked to list their very close and somewhat close alters on a series of post-it notes, using the instrument depicted in Figure 16 (assembled as one page for the first part of the exercise). They first listed as many very close alters as they could on one side of the instrument, then flipped it over to list their somewhat close alters. When they could not think of more names, they were asked to label each identified alter by one or more role category, including: immediate family, other relatives, neighbors, coworkers and students, people from organizations, and friends not included above. Often, this categorization step would prompt the household to recall more alter names.

Figure 16: Name Generator (reproduced from Hogan, et al., 2007, p124)



Next, this name generator instrument was taken apart (Figure 16), revealing post-it notes (tags) that the primary household could remove and stick onto a poster with concentric circles representing social closeness—effectively constructing their sociogram. Following Hogan et al. (2007, p126), participants were given four instructions of how to build this sociogram (Figure 17B):

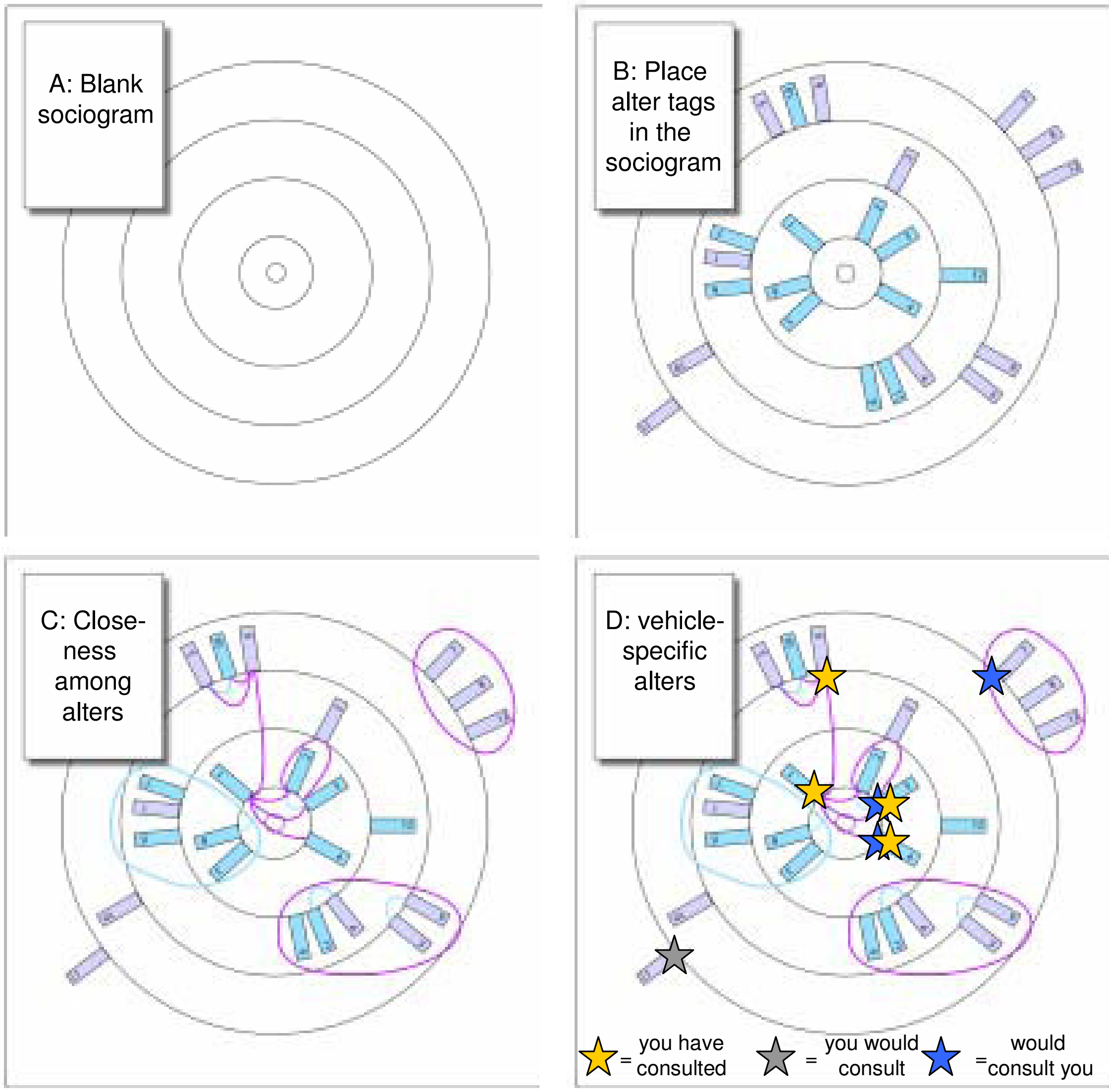
1. “Place each tag on one of the four lines, not between them.

2. The circle represent (social) closeness, so place the closest people to you on the inner circle and work outward.
3. Place people who know each other closer together.
4. Rearrange tags until you are satisfied."

Once the primary household was satisfied with the placement of the tags, they were asked to indicate the social proximity of the alters with one another (Figure 17C). Using the same definitions of "very close" and "somewhat close" they used to distance alters from themselves, they represented closeness among alters as follows (adapted from Hogan, et al., 2007):

- Draw a solid line circle around groups of people (three or more) who are very close with one another.
- Draw a dotted line circle around groups of people (three or more) who are somewhat close with one another.
- Draw a solid line connecting two people who are very close (if not already indicated within a group circle).
- Draw a dotted line connecting two people who are somewhat close (if not already indicated within a group circle).

Figure 17: Constructing the Sociogram (adapted from Carrasco, et al., 2008)



Finally, in a step unique to this dissertation, primary households were asked to identify alters with whom they would likely discuss a vehicle purchase (Figure 17D). Three instructions were given:

- Place a gold star sticker next to any person you have previously talked to when shopping for or considering a vehicle you have bought. This includes a person you had consulted for advice, engaged in discussion about vehicle options, or just used to “bounce” ideas around.
- Place a silver star next to any person you think you would talk to or consult in a similar way regarding a future vehicle purchase decision.
- Place a blue start next to any person you think would talk to or consult you in such a way if they were considering purchasing a vehicle.

For illustration, Figure 17D depicts six vehicle-related alters identified by a hypothetical primary household, four of whom the primary has consulted in the past, one they anticipate consulting in the future, and three they anticipate would consult them in the future. Within each of these categories, primary households were asked to create new post-it tags for alters they had not already been identified as very close or somewhat close. The primary household’s sociogram included separate boxes to place post-it tags for such *casual acquaintances* or *strangers* (not shown in Figure 17).

Another innovation of the present instrument is that after the initial construction of their sociogram, primary households were given several opportunities to adjust or update their representation in subsequent interviews. As noted by Feld, social ties are continually “being created and lost as well as changing their nature over time” (2007, p218). Thus I attempt to account for such dynamics during the several week duration of the primary household’s involvement in the study. The sociogram is also shown to primary households in subsequent interviews to aid recall of social episodes. When the primary household reports interacting with a previously unidentified alter, they are asked to construct a new post-it tag and place it in the appropriate circle of closeness, the casual acquaintance box, or the stranger box.

3.5.3 Secondary participant invitations

After the primary household constructed their sociogram, they were asked to invite five to 10 alters to take part in the study as secondary participants. Researchers provided an invitation sheet (Appendix D), asking the primary household to list at least five alter names before the researchers leave, and then invite those alters within the following week. Researchers explained the reasoning for this task, and assured the primary household that all participant data will be kept private and confidential. After the first week, the primary household was also asked to invite any other alters they contact during their PHEV trial, including casual acquaintances and strangers. Researchers explained that although secondary participants would not take part in the PHEV trial (and thus not drive a PHEV), they will be financially compensated for their time with a $50 gift card for completing the online survey, and an additional $50 gift card for taking part in a 30-minute phone interview (if invited by the researcher). The primary household was provided three methods of inviting secondary participants:

1. In person: providing the alter with an invitation business card, which included contact information and a brief explanation of the study.

2. By phone: explaining the study to the alter and providing contact information (either reading from the business card or the recruitment sheet in Appendix D).
3. By email: forwarding an email to the alter, as provided by the researchers (Appendix E).

In all cases, the onus was put on the secondary respondent to initiate contact with the researchers; the primary household was not asked to share contact information for invited alters without their permission.

3.5.4 The social episode diary

Each participating member of the primary household was asked to complete a *social episode diary* for the duration of their PHEV trial. A social episode diary (also known as a contact diary or self-reported interaction log, among other names) is simply a record of the participant's interactions with alters over time. Diaries were employed in the present study for three main reasons:

1. *Validating/improving the social network*: after primary households initially map out their sociogram, the diary helps generate additional names that were initially forgotten or unanticipated as in the case of encounters with strangers brought about by the primary participants' driving the PHEV.
2. *Aid retrospective recall of social episodes*: the diary serves as a record keeper to help the participant recall and report social interactions during interviews. Further,

participants may be able to record additional insights while the experience is still "hot" (Duck, 1991, p151), rather than waiting up to two weeks for the next interview.

3. *Reflexively informing the participant*: diaries also serve a reflexive role for the participant, helping them to "review the entire range of the [their] areas of daily life, with circumstances and places of contact" (Degenne and Forse, 1994, p20). Allowing participants to take a new perspective on their social interactions may help them better assess the influence such interactions have on their own perceptions and behavior.

Compared to direct observation and interviews, diaries are more "familiar, natural and unobtrusive to respondents" (Fu, 2007, p196) but can also be "tedious, demanding, and sometimes even overwhelming" (p198). Duck (1991) explains that diaries can effectively explore interpersonal behavior if the instrument is well structured, regularized and comparable across situations. He explains the Rochester Interaction Record, which asks respondents to report the following for each interaction: date, time, duration, number of people present, nature of the interaction, intimacy, satisfaction, initiation, and magnitude and direction of influence. A comparatively complex instrument, the Iowa Communication Record, asks a total of 36 questions for each interaction.

To minimize participant burden in the present study, I utilized a relatively simple diary structure (Appendix F). Primary participants were instructed to record only interactions that pertain to the PHEV, electric-drive vehicles, or vehicles in general. For each entry, they were asked to report date and time, who was involved, who initiated the interaction, where it took place, and note what was said by each person. Participants were asked to keep the diary instrument in their PHEV or on their nightstand so they would update it on a regular, ideally daily, basis. Because participants had already completed a sociogram (which they updated at each interview), the diary did not require details about the alter other than name. Further, the diary did not require respondent assessments of feelings or ratings of influence, as these were collected in later interviews. In effect, the primary role of the diary was to help jog the participant's recall of social interactions so they could deliver more complete reports in interviews. Secondary participants were not asked to complete a social episode diary; for the present study it was only feasible to formally explore their interactions with the primary household.

3.5.5 Ranking influence of experiences

After the primary household reported their social interactions and formulated their overall assessment of PHEV technology in the closing interview, they were asked to assess the influence different experiences had over their PHEV assessment. To assist with this task, I designed an *influence ranking exercise*.[11] This exercise was in part inspired by researcher observations that "respondents are generally better able to answer questions that pertain to events that are specific, objective and recent, rather than general, subjective and temporally distant" (Metts, et al., 1991, p169). Thus, rather than asking a respondent a general question (were your social interactions influential?), it may be better

[11] The exercise is actually a hybrid of ranking, i.e. relating items to one another, and rating, i.e. using an absolute scale—a numerical rating scale is provided to help participants rank experiences. However, throughout this dissertation I refer to the exercise only in terms of ranking.

to ask more specific questions (was experience X more influential over your PHEV assessment than experience Y?). To do so, I first distilled a list of the primary household's experiences during their PHEV trial as they reported in prior interviews. Experiences included three categories:

1. *Technology*: experiences with the PHEV itself, such as using it to commute to work, plugging it in at home or elsewhere, and watching the Prius monitor.
2. *Social*: all social interactions reported by the participant.
3. *Research*: all tasks required by researchers, including filling out the online surveys, taking part in each interview, and completing the social interaction diary.

Appendix J describes the exercise protocol in more detail. Each identified experience was placed on a post-it note. For simplicity, only two categories were presented to participants: yellow tags for experiences with "things" (technology and research instruments), and pink tags for experiences with "people" (social interactions and interviews with researchers). The participant was then asked to place each post-it note on a poster board representing how influential the experience was on their PHEV assessment (Figure 18). The poster depicts a 10-point scale, where a ranking of 10 represents the most influential experiences, and a ranking of one represents the least influential experiences. For example, Figure 18 depicts a hypothetical respondent who ranked "talking to Dad" and "driving to/from work" as the two experiences that were most influential over their assessment of the PHEV, while "talking with sister" and participating in "interview #2" as the two least influential experiences. Although yellow and pink tags were ranked on different sides of the instrument, the scale was common to all tags. Participants were asked to “talk through” this exercise, explaining why they ranked each experience as they did. The main objective of the exercise was to elicit the participant’s explanation of what made an experience influential for them, and how they linked it to their PHEV assessment.

Because contact with secondary participants was limited to the on-line survey and phone interview, they did not complete this ranking exercise. Instead, the online survey (Appendix K) and phone interview (Appendix L) directly asked “how influential was the primary respondent in your overall assessment of PHEVs?” The survey provided a closed-ended response (highly, somewhat or not influential), while the phone interview allowed for more open-ended responses and storytelling.

Figure 18: Experience influence ranking exercise (yellow post-it notes for interactions with "things," pink for interactions with "people")

3.5.6 Semi-structured interviews

As noted above, interviews were the main point of contact with primary households and secondary participants. An important purpose for the online survey, sociogram construction exercise, social episode diary, and experience ranking exercise was to help inform and structure participants' responses in the interviews. In addition to these structured exercises, important insight can be gleaned from the inclusion of semi-structured research components, as has been demonstrated in previous consumer research for HEVs (Heffner, et al., 2007) and PHEVs (Caperello and Kurani, 2010). Burnett (1991, p121) promotes the use of *semi-structured interviews* in social influence research:

> *"By turning persons into research subjects with non-speaking parts in the script of social science, much investigation of interpersonal interaction can seem like an elaborate prologue to a play in which the characters are denied their lines. Unless we let actors say what they mean, then the content of that play is reduced; however elaborate an outsider's commentary on the central action, it is no substitute for the story itself as told by insiders…I advocate an approach to studying social interaction using methods that include a means of accessing people's own meaning."*

Heffner (2007) refers to "in-depth interviews" (p93), "long interviews", and "ethnographic" interviews. He notes that use of the latter term can be controversial if it does not involve the long-term exposure and direct observation of participants in a natural setting that is typical of anthropological work. However, Heffner (2007, p93) adds that *ethnographic research* may be more loosely defined according to Atkinson and Hammersley's (1994) four part definition as research that is:

1. "exploring social phenomena rather than testing hypotheses,
2. working with uncoded data and without predetermined analytic categories,
3. investigating a limited number of cases, and

4. conducting analysis that requires the researcher to interpret verbal descriptions to determine the meaning of behavior."

McCracken (1988) contrasts semi-structured interviews (or what he calls the "long interview") with an unstructured, ethnographic approach—the former is "deliberately more efficient and less obtrusive." He states that semi-structured interviews are carefully designed to investigate particular ethnographic objectives without commitment to prolonged involvement in the participant's community. Although aspects of the present study satisfy each of Atkinsons and Hammersley's requirements for ethnographic research, I will use the term semi-structured to describe my interview instruments.

Semi-structured interviews blend structure and open-endedness. The researcher first constructs a questionnaire that will help to guide the overall structure of interview and to assure that key topics are discussed with each participant in roughly the same order. However, the researcher does not methodically run though the questionnaire with each participant but instead treats each interview as a unique social encounter—seeking to develop a natural dialogue with the participant. The researcher also seeks to establish trust and build rapport (Heffner, 2007), creating an environment where the participant feels comfortable in sharing personal information and expressing their thoughts and feelings without being judged. Further, the researcher must provide space for the participant to tell their story in their own words. McCracken (McCracken, 1988, p21) notes how "at crucial moments in the interview, the entire success of the enterprise depends upon drawing out the respondent in precisely the right manner…an error here can prevent the capture of the categories and the logic used by the respondent." The researcher is also free to pursue and explore new insights that arise during the interview, even if it requires temporary departure from the prepared questionnaire. Throughout these interactions, the researchers seeks to appear engaged, but unobtrusive and detached, portraying himself as "a benign, accepting, curious (but not inquisitive) individual who is prepared and eager to listen to virtually any testimony with interest" (McCracken, 1988, p38).

Each semi-structured interview conducted in this study lasted from one to two hours. The first and last interviews are outlined in Appendices A and I, respectively, which lasted about two hours. Other interviews, i.e. the PHEV drop-off and mid-term "check-ups," lasted about one hour, and utilized even less structure. All interviews were recorded and later analyzed by researchers. Like Heffner (2007, p10), each interview was conducted in the respondents' home "to have the interview feel as much like a normal social encounter as possible."

Semi-structured interviews were used to elicit three main types of information from participants: i) *retrospective recall* of their experiences, ii) their *assessment* of the PHEV technology and how it fits into their lifestyle, and iii) a *narrative* of how their experiences relate to their assessment. First, *retrospective recall* can be an effective way to explore the participant's histories, the meanings they assign to their experiences, and their attitudes, emotions and perceptions relating to experiences (Metts, et al., 1991). Metts et al. (1991, p167) explain that this approach helps to "explore the complex, multidimensional nature of relationship/interaction constructs and the multi-causal nature of the phenomena." In the present study, retrospective recall was elicited with open-ended questions about past experiences, such as vehicle purchase history ("tell me how you came to purchase your Honda Civic") or the PHEV trial ("tell me about your PHEV trial" or "about plugging in the car"), followed by more specific prompts or requests for elaboration to elicit details of their experiences. Metts et al. (1991, p163) note that although retrospective recall is helpful for eliciting subjective data, it can be less effective from an objective standpoint; for instance, they warn that recall of interpersonal experiences are biased towards: "(1) the gist of the conversation rather than verbatim messages, (2) verbal rather than nonverbal behavior, (3) one's own message rather than partner's, and (4) the presence or absence of specific statements rather than frequencies of occurrences of behaviors". I attempt to mitigate these limitations through use of the social episode diary, as well as using prompts to elicit such typically omitted content.

The participant's overall *assessment* of the PHEV technology was elicited in the closing interview for primary households, and in the phone interview with secondary participants. All participants were asked general questions of what they thought about the PHEV, and about certain activities like plugging in, refueling and recharging. The PHEV designs games explained in Section 3.5.1 were used to elicit more specific details of the participant's assessment; researchers would show them (or in the case of phone interviews, explain to them) the PHEV designs they had previously constructed via the online survey. Participants were asked to explain their design process in as much detail as they could, and to link this to their intention or lack of intention to purchase a PHEV in the future. By then end of these exercises, participants would typically distill their PHEV assessment to several key benefits and drawbacks, and offer their overall inclination to purchase such PHEV under different conditions.

Finally, researchers sought to link the participant's experiences and PHEV assessment by co-creating the participant's *narrative* with them. Burnett (1991, p122) summarizes Gergen and Gergen's (1987) definition of a "well formed narrative:

1. it should have a goal-state, that is, there is a point in telling it;
2. events must be selected that are relevant to that goal state;
3. events are generally arranged chronologically;
4. one event should lead logically (often causally) to another; and
5. it has demarcation signs, such as 'in the beginning.'"

Eliciting data in narrative form can be a highly effective way to understand subjective experience, challenge research preconceptions and cultivate new perspectives on social phenomena (Burnett, 1991). Further, as explained in Section 2.3.5, a narrative approach is highly consistent with Giddens' (1991) reflexivity perspective, where individuals come to understand themselves by linking their past, present and future into a cohesive "trajectory of development" (p75) or narrative. Giddens posits that this narrative must "continually integrate events which occur in the external world, and sort them into the ongoing 'story' about the self" (p54)—thus it might be possible to discover how an individual fits the experiences of their PHEV trial into their own lifestyle, and how it affects their self-concept. Of course, eliciting narratives can be challenging, where "to invite people to provide their own account is to give them opportunity to show off, to ramble irrelevantly, and to deceive" (Burnett, 1991, p121). This is another reason why the semi-structured interviews included structured exercises, such as the PHEV design games and influence ranking exercise, to provide context for the participant's story. Further, the order and wording of the final interview questionnaire (Appendix I) intentionally guides the participant to respond in narrative form: it is structured around the goal-state of their PHEV assessment, prompts are ordered chronologically (beginning with the participant's initial expectations, moving to their PHEV trial experiences, then concluding with their assessment), and the influence ranking exercise elicits their perceptions of causality between their experiences and assessment.

However, participants often cannot construct a complex (or accurate) narrative on their own. Metts et al. (1991) explain that a participant may not actually know why they behave or perceive in a particular way, and if asked, "they may rely on implicit causal theories provided by the culture to explain their response" (p168). Such a tendency may be particularly problematic in the present research, where participants could be unaware of the role of social influence in their PHEV assessment, or do not want to admit the occurrence of social influence that may counter their self-perceptions or values of independence. For this reason, the final construction of the participant's narrative is left to the researcher, who integrates the participant's testimony with data collected from the other research instruments. In this sense, as suggested by McCracken (1988), the researchers serve as instruments themselves, compiling all available data about the participant as well as personal knowledge and experience of cultural context to pull together the final narrative.

3.6 Data analysis

The data collected from the study design and research instruments are analyzed and reported in the next three chapters. Earlier in this chapter, I espoused the value of following a primarily qualitative and interpretive research approach given the exploratory nature of this dissertation's objectives. However, before delving into the in-depth interview testimony and narratives in later chapters, Chapter 4 first provides descriptive, empirical results collected from participants with the relatively structured research instruments. I reason it is useful to start with a birds-eye view or map of the terrain (data) to help plan this dissertation's subsequent journey of analysis and inquiry. First, I use survey and sociogram data to describe the distributions of participant demographics, beliefs and knowledge and the structures of their social networks. I also explore the first and most straightforward research question (does social influence matter?) by compiling results from primary households' completion of the experience influence ranking exercises. I also code each reported social interactions according to available characterizations, e.g. pro-societal content and social proximity, in order to seek out general patterns of social influence using two statistical analysis tools: two-way tests of independence and logistic regression analysis. These results help to guide and frame my qualitative explorations in the next Chapters

In Chapter 5, I begin to explore the qualitative data in more depth by applying McCracken's method of analytic discovery (1988). For each primary household, I reviewed interview recordings of each interview and produced a selective transcript. I integrated these transcripts with information from their online survey responses, sociogram, social episode diary, vehicle use patterns, and influence ranking results to produce two narratives of their experiences. The first narrative details their PHEV trial, including the participants' household context, vehicle purchase history, PHEV driving behavior, recharge behavior, use of instrumentation (the Prius monitor and provided V2Geen website), perceptions of energy use and overall assessment of the PHEV technology. The second narrative is a more detailed account of the participant's social behavior, including their social network, previous consultation of alters regarding vehicle purchases, and reports of social interactions during their PHEV trial, along with mini-narratives elicited from their recruited secondary participants. As outlined by McCracken, I first treat each "useful utterance" (p44) or observation relating to social influence on its own terms. I then look for themes across observations within the household, and finally across households. In Chapter 5 I analyze these themes and observations according to the five perspectives identified in Chapter 2's literature review: contagion, conformity, dissemination, translation and reflexivity. In essence I "try on" each perspective to illustrate what insights it provides into processes of social influence from the data I have compiled, and tease out clues to guide further analysis of the data in later Chapters.

Chapter 6 delves deeper into the use of narratives to answer the third research question—exploring the social conditions that not only facilitate the adoption PHEVs, but also the adoption of pro-societal values. Full-length narratives of four primary households are portrayed and analyzed to demonstrate the importance of three social conditions. Finally, Chapter 7 draws from themes identified across participants to form a new, integrative theoretical framework of how social influence can affect vehicle purchase behavior. After laying out this framework, I test its validity in application to observed data.

3.7 Some limitations

Inevitably, this research methodology has many limitations, some of which have been noted above. Several key limitations are summarized here:

- **Vehicle assessment:** the study is designed to elicit consumer assessment of the vehicle technology, not vehicle purchase behavior. Because the relationship between technology assessment and purchase behavior is not clear, it may not be appropriate to generalize the themes yielded in this study to vehicle purchase behavior.
- **Temporal boundaries:** the only social and technology experiences that are elicited and analyzed in depth occur during the PHEV trial. Of course, the participant may have had social or technology experience prior to their PHEV trial that shaped their PHEV assessment in important ways. While researchers did attempt to elicit details of participant histories regarding vehicle purchase behavior and environmental values, the present results are largely focused on

PHEV trial experiences, and may miss the importance of experiences beyond this scope.

- **Social interactions:** the study design assumes that social interactions are the appropriate unit of analysis for interpersonal influence. However, social influence can occur through processes that are less tangible than specific interactions. For instance, a participant may have a general perception or sense that people are watching him as he drives the PHEV, but does not have a specific social interaction to report. Further, a participant that develops a particular social norm or belief through numerous social interactions and various media messages over time may be unable to attribute it any one source, or may have internalized the belief such that they perceive no social influence.
- **Neglecting mass media:** some interpersonal influence research perspectives, such as diffusion, often consider sources of information beyond interpersonal contact, such as newspapers, news programs, advertising, online postings and government messages. Although participants were free to report such experiences during their PHEV trial, research instruments such as the social episode diary focused on interpersonal interactions.
- **Technological context:** the PHEV Prius used in this study is only one particular incarnation of the technology. Further it is has been converted from a vehicle model, the Toyota Prius, which has already been in the U.S. market for a decade and thus has many pre-existing interpretations and symbolic denotations that may have nothing to do with a PHEV, but may still influence the participant. This fact may lead to less social interactions (given that the vehicle is not easily identifiable

as something “special”), more social interactions (because there is more to talk about with an existing, highly symbolic vehicle model), or otherwise change the quality of interactions relative to unique PHEV model. Thus, it may be difficult to generalize these findings to the context of new PHEVs built by automakers on a unique platform, e.g. the Chevy Volt.

- **Subjective bias:** relying primarily on respondent recall means that some experiences may be forgotten, inaccurately recalled or embellished. Further, some participants may not be conscious of how social experiences are influencing them, and thus may not identify social influence where it is occurring at a more subtle level. At the same time, the interpretivist viewpoint (as opposed to positivism) suggests that such phenomena are an inevitable part of the human experience, and should thus be included in behavioral research.
- **Regional context**: all primary households and most secondary participants are residents of Northern California, and thus the sample does not likely represent the full breadth of personal values and cultural contexts that exists among other U.S. car buyers.
- **Social desirability**: although researchers seek to build an optimal level of distance between themselves and participants, in the context of the study participants may still feel the need to act and respond in ways they perceive as being desired by researchers. For instance, participants may want to portray themselves as more intellectual, rational or pro-environmental in their PHEV assessment, or try to engage in more social interactions than usual to “fill up” their social episode diary.

- **Selection bias**: all recruited primary households had initially responded to an invitation by AAA, and thus this sample may contain a disproportional amount of participants interested in electric-drive vehicles, driving a "free car," or research participation in general. Recruited secondary participants may have had similar motivations, or were in particularly attracted to the $50-$100 compensation.

Despite these and other limitations, I judge that this exploratory research is still capable of identifying important themes and patterns of social influence in the context of PHEV assessment, and answering the research questions I've posed.

4 Empirical Results: Does Social Influence Matter?

This Chapter presents descriptive results of this study. Before testing, revising and constructing behavioral perspectives and theories in later chapters, I first take an agnostic tone and report information about the participants and begin to describe and explore the empirical social interaction data. The first sections describe the sample of primary households and secondary participants based on various individual, household and social network characteristics, and compare these to other samples. I then use results from the experience ranking exercise to explore the first research question of this dissertation: does social influence matter? Further, I employ statistical techniques to begin an exploration into the conditions that make social interactions influential.

4.1 What does the sample look like?

Figure 19 depicts the geographic distribution of the sub-sample of 10 primary households (18 individuals) as well as the 22 secondary participants they recruited. All primary households and most secondary respondents reside in the Sacramento, CA area—five secondary participants reside elsewhere (the San Francisco Bay Area, the Sierra Foothills and Pennsylvania).

Figure 19: Geographic distribution of primary households and secondary participants

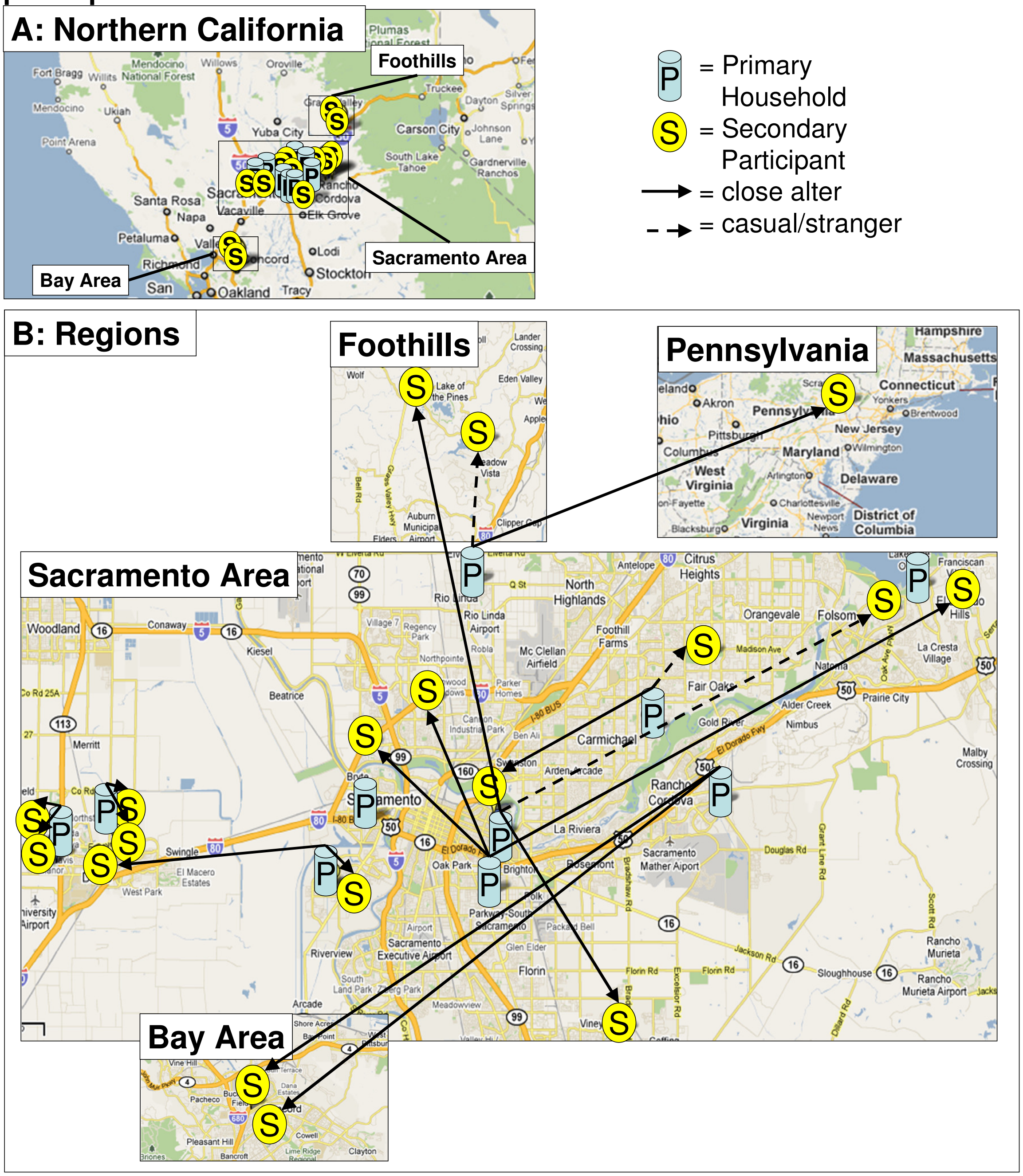


Table 7 depicts participating primary household members and their recruited secondary participants, grouped by the eleven social networks. Although there are only 10 primary households, the daughter of the Stashes opted to construct her own sociogram independent of her parents'. In addition to age and income, Table 7 also categorizes each participant according to demonstrated lifestyle practices. These categories were established by researchers based on observations from interviews and surveys, and often relate to the participant's vehicle interest. For example, "recreation" participants devote much of their time to activities such as golfing, skiing or camping, and consider such activities when selecting a vehicle for purchase. "Family" participants tend to spend most of their time with their children and perhaps extended family, and may select vehicles based on family concerns such as passenger capacity. "Environment" participants devote significant time and resources to environmental concerns, such as consistently recycling, buying organic foods, composting, and may have considered or purchased an HEV or fuel-efficient vehicle in the interest of reducing their environmental impacts. "Technology" participants are highly interested in researching and purchasing new products, such as those that have built or are planning to build their own EV. "Work" participants are career focused, "students" engage primarily in schooling activities with a limited income, and "construction" participants take part in handyman projects and tend to be interested in pickup trucks that can haul tools and supplies.

Table 7: Characteristics of primary households and secondary participants

Primary Surname	First name (**Primary**)	Age	Household income	Lifestyle practices	Relation to primary	For primary: Social proxim.[2]	For primary: Infl.	For secondary: Social proxim.	For secondary: Infl.
Woods	**Billy**	40s	$100-124k	Recreation/ social					
	Pat (F)	40s	$70-79k	Family	Girlfriend	V. close	Low	V. close	High
	June (J)	40s	$80-89k	Rec.	Friend	S. close	High	V. close	High
	Chris (K)	40s	$80-89k	Rec.	Friend	S. close	n/a	V. close	High
	Harry (R)	40s	$125-149k	Enviro./tech.	Coworker	Stranger	High	Stranger	Low
Noel	**Rupert**	40s	$80-89k	Family					
	Amy	40s	$80-89k	Family					
	John	60s	$125-149k	Family/tech.	Coworker	S. close	Mod	Casual	Mod
	Ray	20s	$70-79k	Family	Friend	S. close	High	V. close	Mod
	Anita	30s	$125-149k	Family	Friend	V. close	Mod	V. close	High
Petrov	**Adam**	60s	$40-49k	Tech. /construction					
	Katrina	30s	$40-49k	Student					
	Pavel	20s	$30-39k	Rec./tech.	Son	V. close	High	V. close	Low
Earhart	**Betty**	30s	$50-59k	Work/family					
	Hazel	40s	$50-59k	Family	Friend	Casual	Low	S. close	Mod
	Macy	20s	$70-79k	Student	Daughter	V. close	High	V. close	Low
Stashe	**Darren**	50s	$100-124k	Work/family					
	Pat	50s	$100-124k	Work/family					
	Cliff	30s	$100-124k	Work	Coworker	Casual	Low	S. close	Low
	Melissa	20s	$100-124k	Student					
	Graham	20s	$80-89k	Recreation	Friend	S. close	High	S. close	Mod
Ranchero	**Ed**	30s	$100-124k	Family/tech.					
	Silvia	30s	$100-124k	Family					
Potter	**Ethel**	50s	>$150k	Family					
	Jane	20s	$40-49k	Rec.	Daughter	V. close	Mod	V. close	Low
	Christy	20s	n/a	Student/rec.	Daughter	V. close	Low	V. close	Mod
	Tom	30s	$70-79k	Construction	Son-in-law	S. close	Low	V. close	Mod
Fort	**Brett**	40s	$100-124k	Family/rec.					
	Julie	20s	$100-124k	Student					
	Selena	40s	$100-124k	Family/rec.	Wife	V. close	High	V. close	High
	Guy	30s	$125-149k	Tech.	Neighbor	S. close	Low	V. close	Mod
	Lindsey	40s	$60-69k	Family	Friend	S. close	Low	V. close	Low
McAdam	**Craig**	40s	>$150k	Enviro./tech./ soc.					
	Siobhan	40s	>$150k	Enviro./soc.					
	Hannah	30s	$20-29k	Enviro./soc.	Friend	V. close	Mod	V. close	High
	Steve	40s	>$150k	Enviro./tech.	Friend	V. close	Mod	V. close	Mod
Rhode	**Larry**	40s	>$150k	Fam./enviro. /tech.					
	Cheryl	30s	>$150k	Fam./enviro.					
	Nicole	50s	$100-124k	Fam./enviro.	Neighbor	S. close	Low	S. close	Low
	Betty	30s	$100-124k	Fam./enviro.	Friend	S. close	High	S. close	Low

Table 8 compares demographic distributions for primary household members, secondary participants, previous California samples of new car buyers, and the general California population. It is generally assumed that the U.S. or California population of new vehicle buying households is skewed towards higher education, age, and income relative to the general population. Samples in Table 8 support this assumption, where the primary household members in this sample tend to be of higher education, age and income than the general population (with 60 percent higher average income than the comparable general population)—though income is proportionally higher than other samples of new vehicle buyers (which are 37 to 45 percent higher than comparable general populations). The sample of secondary participants generally includes a wider distribution of education levels and incomes than the primary households. Because I am following a qualitative approach with limited sample size, the goal of this research is not to necessarily produce a representative sample of car buyers, but instead to include participants from a breadth of demographic categories.

Table 8: Comparing participants, new vehicle buyers, and the general population

Target		PHEV Demo AAA members		New vehicle buyers			General population	
Year		2008-9	2008-9	2007	2007	2001	2005-7	2000
Data source		Primary Households	Secondary Participants	PHEV Survey (Nor. Cal.)[a]	PHEV Survey (Cal.)[a]	NHTS[b] (Cal.)	ACS [f] (Cal.)	Census [g] (Cal.)
Sample size		18	22	216	851	389		
Hybrid owner?	Yes	2	1	8.9%	10.6%	-	-	-
	No	8	21	91.1%	89.4%	-	-	-
Gender[c]	Male	8	10	59.7%	48.5%	44.5%	50.0%	49.7%
	Female	10	12	40.3%	51.5%	55.5%	50.0%	50.3%
Education[d]	High school or lower	0	1	2.6%	8.8%	22.1%	43.0%	43.3%
	Some college	3	7	34.9%	33.9%	22.1%	20.4%	22.9%
	College degree	4	11	32.8%	39.5%	39.9%	26.3%	24.2%
	Graduate degree	3	3	29.7%	17.8%	15.9%	10.4%	9.5%
Age[c]	teens	0	0	0.5%	0.4%	0.3%	9.6%	9.2%
	20s	2	6	15.2%	11.5%	13.2%	18.6%	18.7%
	30s	5	6	24.0%	24.9%	23.2%	18.7%	21.3%
	40s	7	8	31.2%	29.8%	25.3%	19.1%	19.5%
	50s	3	1	14.5%	18.2%	18.2%	15.1%	13.1%
	60s	1	1	11.6%	12.0%	13.5%	9.0%	8.2%
	70s	0	0	3.0%	3.3%	6.3%	9.9%	10.0%
Household income	< 30 k	0	1	1.8%	2.0%	6.3%	25.3%	31.2%
	30 k to 60 k	2	3	11.9%	17.6%	23.4%	25.8%	29.5%
	> 60k to 100k	1	9	35.1%	27.7%	32.3%	23.0%	22.1%
	> 100k	7	8	51.2%	52.7%	38.0%	25.8%	17.3%
	Mean income[e]	$118,500	$91,786	$106,949	$104,814	$84,416	$73,944	$61,441
	Ratio of mean incomes (new vehicle buyer/gen. pop.)	1.60	1.24	1.45	1.42	1.37		
Housing type[d]	Detached house	9	18	71.3%	68.1%	79.4%	58.0%	
	Attached house	1	1	10.3%	11.9%	4.4%	7.0%	
	Apartment	0	1	17.9%	16.7%	13.6%	30.7%	
	Mobile home	0	0	0.5%	3.4%	2.6%	4.2%	

[a] U.S. weights provided by Harris Interactive.
[b] NHTS sample limited to responding California households that had purchased a vehicle of model year 2001 or 2002.
[c] For PHEV Project: data reported for all participants; for PHEV survey: data only reported for responding member of household.
[d] For PHEV Project and PHEV survey: data only reported for responding member of household.
[e] Mean approximated from the product of middle values assigned to each income category and the proportion of the sample in that category.
[f] 2005-2007 American Community Survey 3-year estimates, California.
[g] 2000 Census by the U.S. Census Bureau

The present sample also appears to be similar to other samples of new vehicle buyers on several other characteristics. Figures 20, 21, 22 and 24 compare primary household and secondary participants' responses to the online survey (detailed in Section 3.5.1) to those of the representative California subsample of the nationwide survey summarized in Section 1.3. Participants in the present study faced significantly lower gasoline prices than the California survey respondents did in December of 2007 (Figure 23). However, the present participants do not appear to have a substantially different range of beliefs towards climate change, air pollution or foreign oil independence (Figure 21), nor did they have a different range of experience levels with electric drive vehicles (Figure 22).

Figure 20: Comparing gasoline prices from year 2007 survey respondents (lines), primary participants (diamonds) and secondary participants (circles)

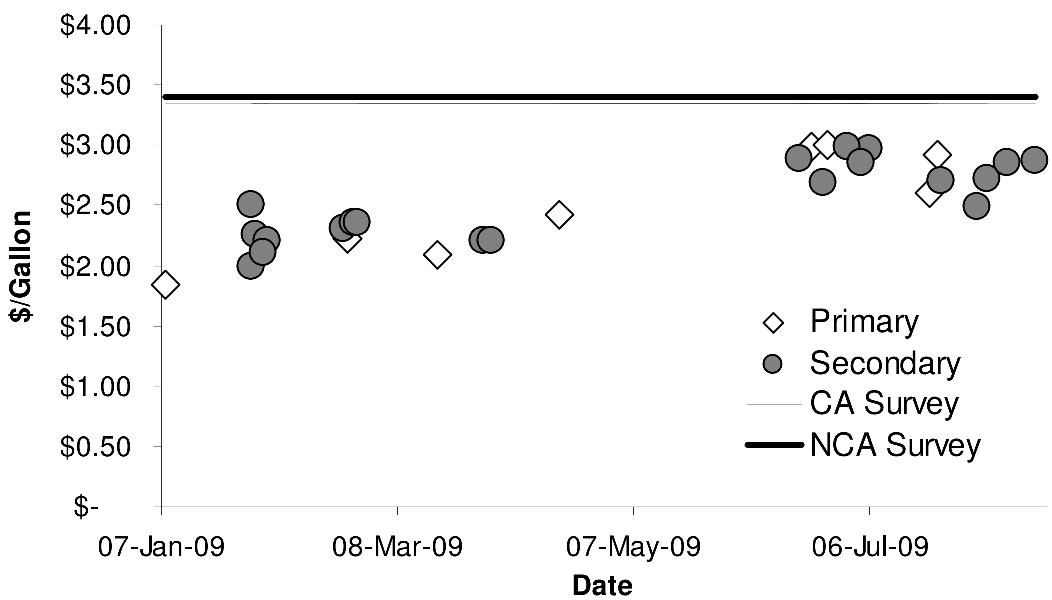


Figure 21: Comparing environmental beliefs among survey respondents ("CA" and "NCA") and participants ("Primary" and "Secondary")

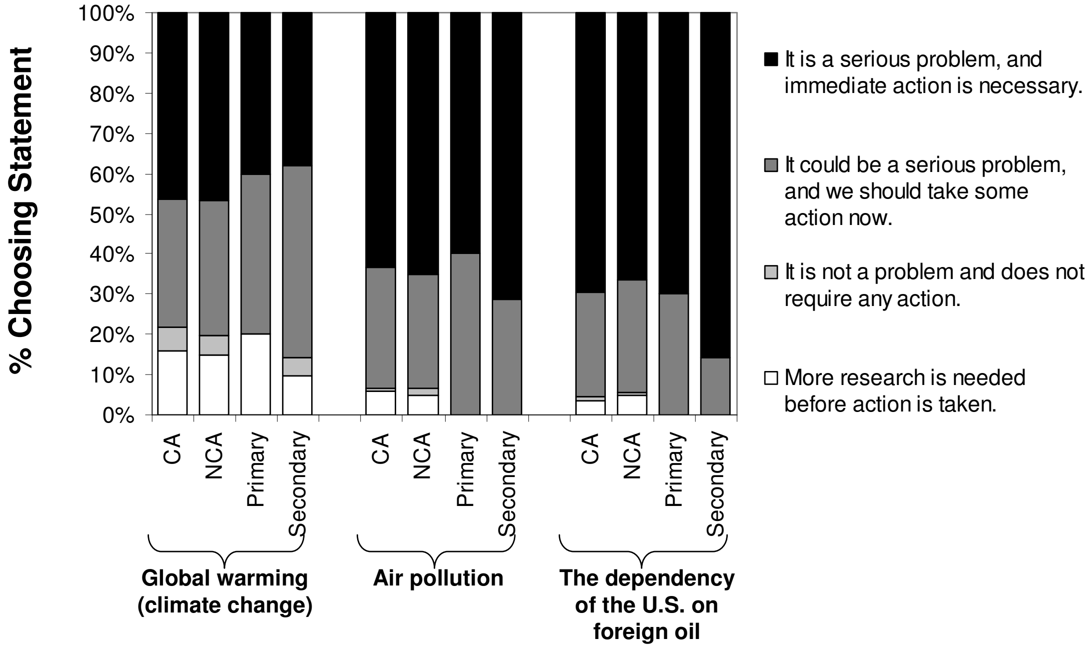
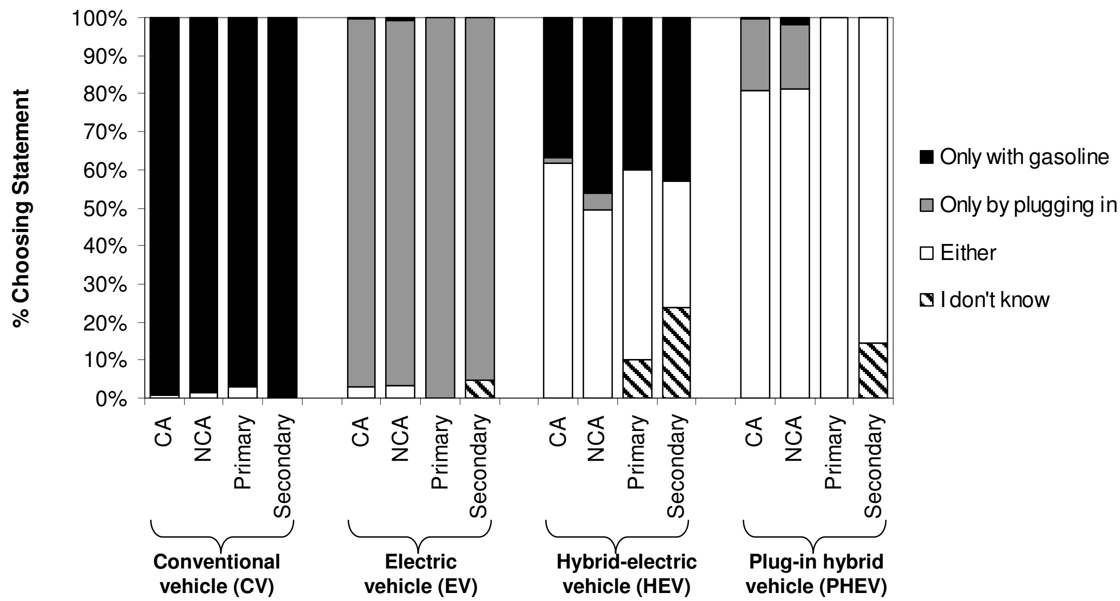


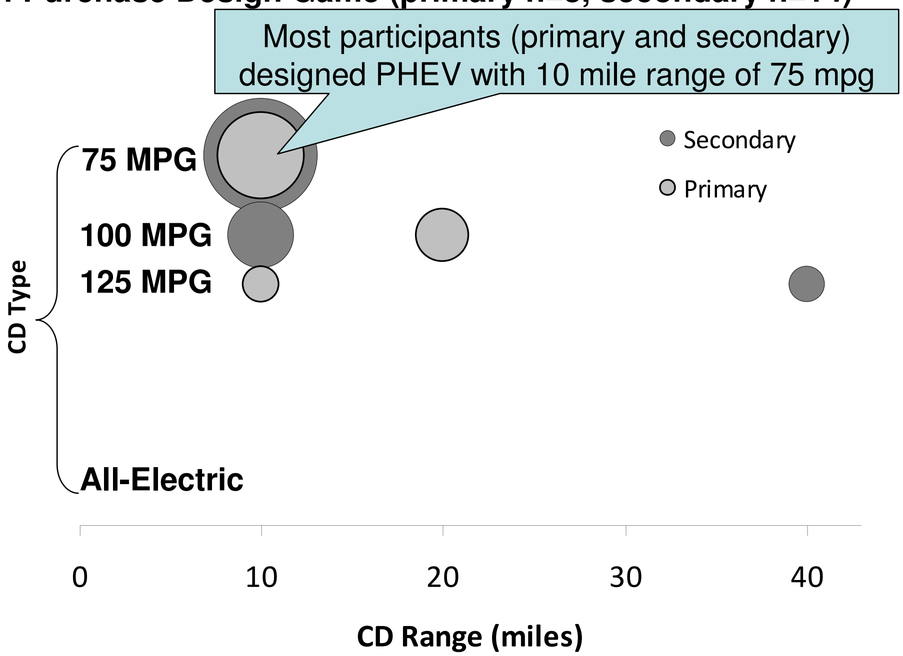
Figure 22: Comparing electric-drive knowledge among survey respondents and participants: "From what you understand of these vehicle technologies, which can use fuel, and which can be plugged in?"



Note: the response "I don't know" was not made available to CA and NCA survey respondents, but was later added for primary and secondary participants.

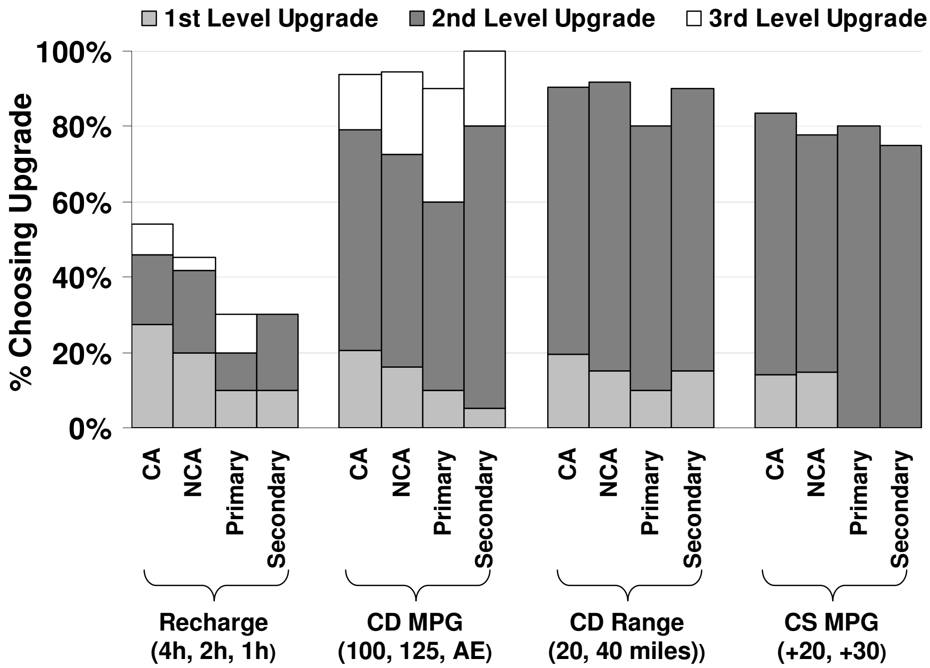
I also compare the PHEV designs elicited by present participants and previous survey respondents in both the *Purchase Design game* and *Development Priority game* (detailed in Section 3.5.1). Recall that each design game allowed participants to select from four types of upgrades to a base PHEV design: recharge time (1 to 8 hours), CD type (AE or three types of B), CD range (10 to 40 miles) and CS fuel economy (10 to 30 mpg better than their conventional vehicle). Figure 23 depicts the distributions of primary and secondary participants design selections in the higher price Purchase Design game according to CD type and range (full design space depicted in Table 6). The size of each light grey circle represents the proportion of primary households (out of the eight that selected a PHEV upgrade in the higher price game) that selected a particular design—most selected the most basic attributes (75 MPG for the first 10 miles). The dark grey circles represent the distribution of secondary participants (again, only those selecting a PHEV upgrade in the higher price game). Thus, as previously found with nationwide and California survey respondents (summarized in Chapter 1), the majority of primary households and secondary participants that designed PHEVs in the higher price scenarios (or the plausible early market participants) were interested in designs with lower charge-depleting (CD) range, and capable of blended (B) rather than all-electric (AE) operation.

Figure 23: Distribution of selected PHEV designs in higher price scenario of Purchase Design Game (primary n=8, secondary n=14)



Primary households and secondary participants also produced a similar distribution of attribute upgrades in round four of the Development Priority game (design space depicted in Table 5). Figure 24 depicts Round four of the Development Priority game, where participants had to allocate six points towards some combination of PHEV upgrades. The distributions of upgrades selected were similar to those of state-wide samples, though with slightly less interest in recharge time upgrades. A possible explanation for this distinction is that primary households and secondary participants had engaged in or been exposed to actual home recharge behavior, and may have seen less need for fast charging capabilities.

Figure 24: Comparing upgrades selected in Round 4 of Development Priority game, (*plausible early market* only: CA, n=286; NCA, n=63; Primary, n=10, Secondary, n=20)



In all, this sample of primary households and secondary participants includes a breadth of characteristics that satisfies the goals of this exploratory research, including demographics, environmental attitudes, electric drive familiarity, and PHEV design interests. Further, the present sample's distributions of these characteristics are surprisingly similar to those of a previous quantitative sample that sought to be representative of California new car buyers.

4.2 Mapping social networks

In addition to personal and household characteristics, I also portray characteristics of the social networks elicited from primary households in this study. As an illustration of the *sociogram* mapping methodology (Section 3.5.2), Figure 25 portrays the sociogram of

Billy Woods, as well as the social interactions observed within his network during his PHEV trial. Billy identified 44 people as *very close* (in the first or second circle of alters) or *somewhat close* (in the third or fourth circle of alters) 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, identified by letters A through K. Billy also mentioned or discussed the PHEV with eight *casual acquaintances* (letters I through Q) who he did not place close to him in his network map, and one *stranger* that he met during his PHEV trial (letter R). Figure 25 also groups Billy's social contacts according to his descriptions of how close they are to one another (with line thickness proportional to the strength of ties), with subgroups labeled where possible, such as "family," "coworkers" and "golf buddies and friends." Recruited 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 that individual to have had relatively higher influence on his assessment of PHEV technology. Thus, his interactions with the stranger "R," casual acquaintance "L," and friends "D" and "E" were more influential to Billy than his interactions with family members "A" or "B," his girlfriend "F," or others. Figure 25 can be viewed as one map of Billy's social network as well as an overview of how his PHEV trial stimulated this network.

Figure 25: Billy Woods' Sociogram

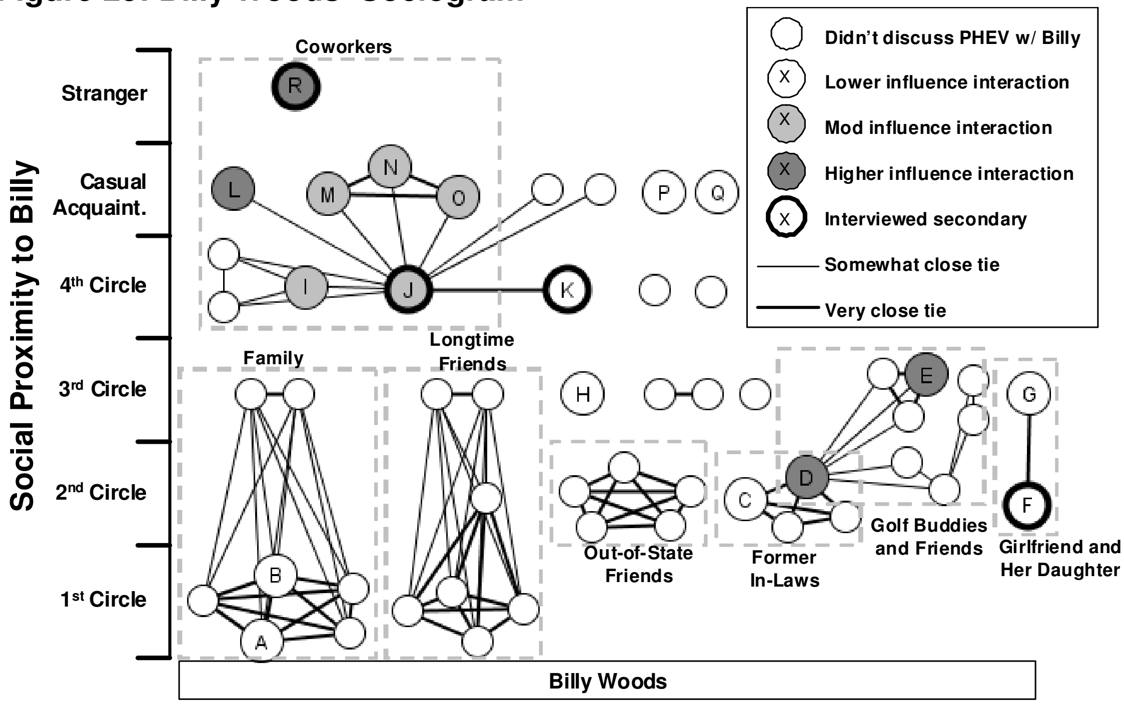


Table 7 depicts the primary households' perspective of the social proximity of the secondary participants and the influence of interactions with them, as well as the perspective of secondary participants. These perspectives are not always symmetrical; for example, although "Chris" (K) considers Billy to be a very close friend who had a strong impact on his perception of PHEVs, Billy did not recall having spoken with Chris during his trial. Asymmetry occurs in the other direction also; Billy rated his interaction with a stranger who was an EV driver, Harry (R), to be highly influential, while Harry in turn did not consider the interaction to be influential for himself.

Figure 26 compares the number and distribution of alters across all 11 social networks. In total, 562 alters were identified, with the majority being classified as either very close (43 percent) or somewhat close (40 percent), followed by the casual acquaintances (14 percent) and strangers (4 percent). Recall that although the former two categories were intended to be exhaustive, the latter two categories were identified by primary households on an ad hoc basis—primarily via social interactions that occurred during their PHEV trial. The total number of close alters per household ranged from a high of 101 (the Noels), to a low of 24 (Betty Earhart). In terms of alters per participating household member (six social networks include two primary participants or egos), the size ranges from 51 close alters (again the Noels) to a low of 13 (the Petrovs and the Rancheros). The mean and mode of close alters per participant (29 and 25, respectively) are higher than those yielded by another study (24 and 21) using a similar methodology in a different region (Hogan, et al., 2007). This difference could result from differing regional context or from the present study's smaller sample size (perhaps skewing the average towards one or more particularly large networks). Also, the present study allowed more opportunities for primary households to adjust their social network by presenting their sociogram at each of the interview—participants often added alters they had forgotten during initial construction of their sociogram (whereas the previous study used only one interview).

Figure 26: Alters and interactions per network, by social proximity

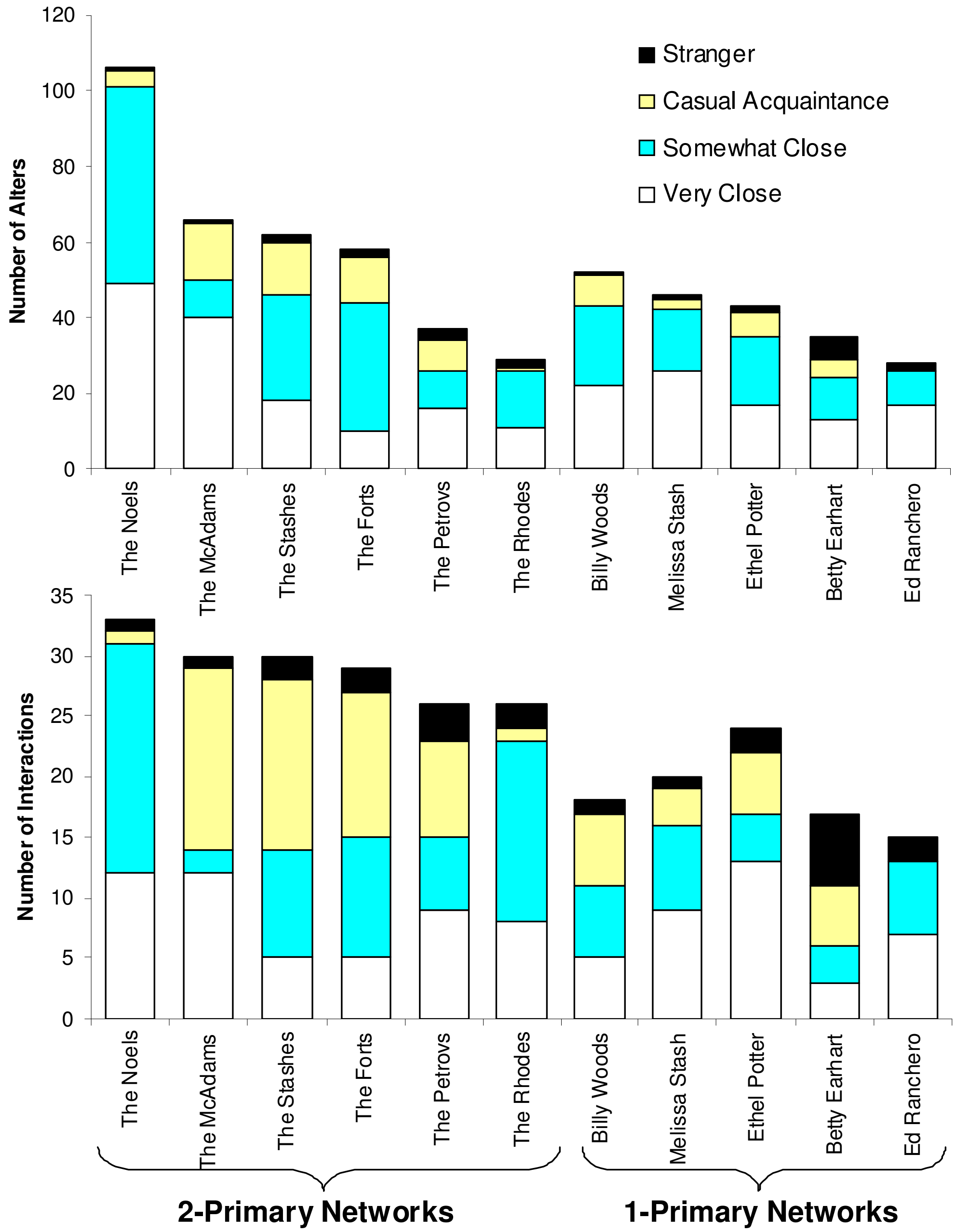


Figure 26 also portrays the distribution of the number of social interactions reported by each primary household. In this dissertation I define a *social interaction* as a set of one or more social episode(s) (verbal or non-verbal communication) between the primary household and one other individual. I select this definition because while respondents typically could recall if they interacted with a particular alter, they often had difficulty separating the details across multiple episodes with that alter—that is, if they discussed the PHEV in three or four episodes, and what was said in the third episode versus the fourth. Thus, I found it was easier to communicate with participants regarding a set of episodes with one alter, and thus elicited data relates to one interaction (as a set of episodes). For example, although Billy Woods discussed the PHEV with June on almost a daily basis during his trial, I record this set of episodes as one social interaction. When Billy Woods discussed the PHEV with a group of three co-workers, three separate interactions are recorded (one for each co-worker). Further, an interaction does not require face-to-face or verbal communication—it may consist of an email, a written note, or a meaningful body gesture such as a wave of the hand or nod of the head.

Using this definition, the ten primary households reported a total of 275 social interactions over the course of their PHEV trials, ranging from 33 (the Noels) to 15 (Ed Ranchero) per network, or 24 (Ethel Potter) to 13 (the Petrovs and the Rhodes) per household member. The majority of interactions took place with either very close (33 percent) or somewhat close (32 percent) alters, followed by casual acquaintances (26 percent) and strangers (9 percent). However, this distribution varies substantially across social networks (Figure 26)—suggesting the importance of further exploring the uniqueness of each social network context.

4.3 Do social interactions matter?

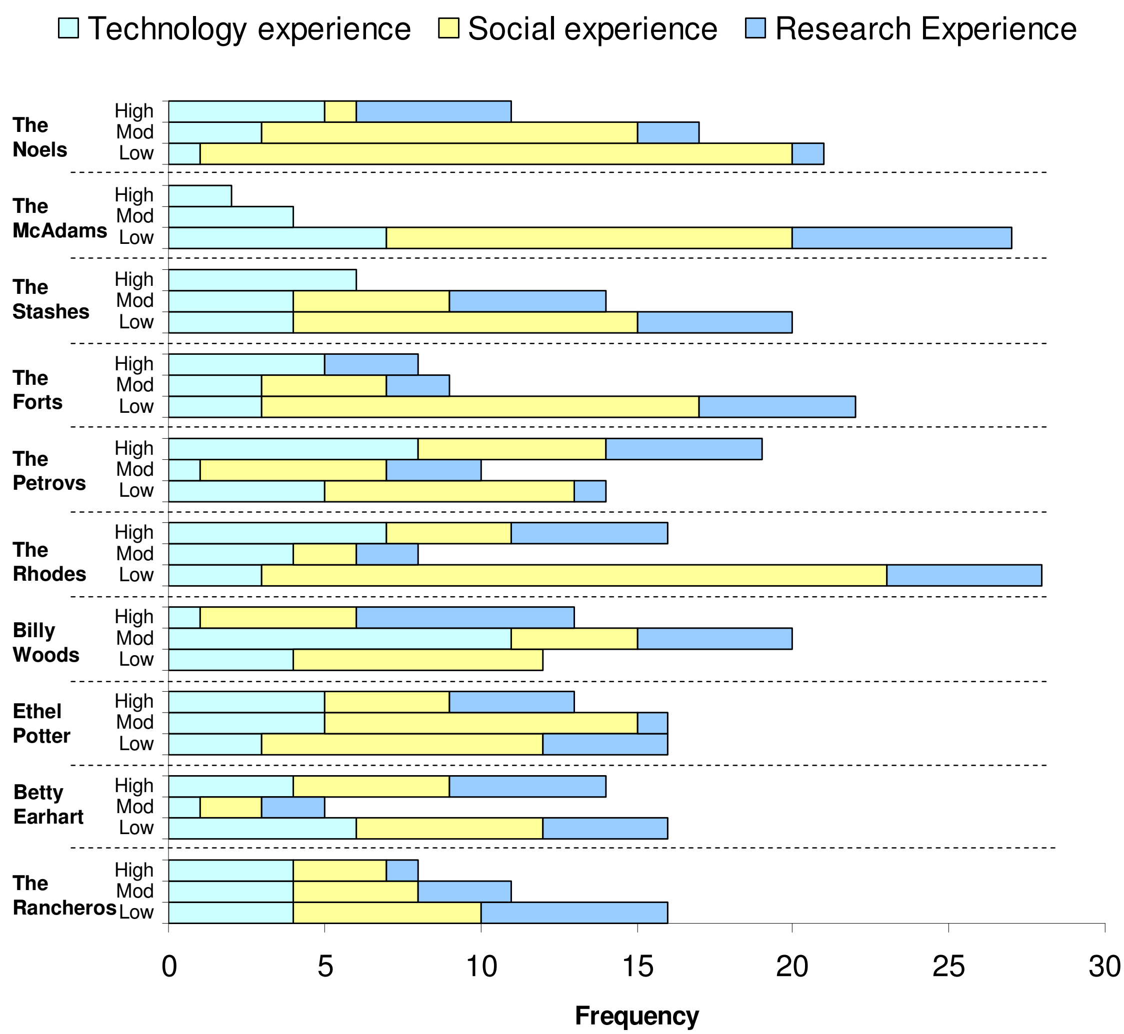
I now use these reported social interactions to begin to explore the importance of social influence. As noted in the Chapter 3, the primary household provided their assessment of the PHEV vehicle technology in Stage 3 of the research design. Afterwards, researchers consulted the participants to generate a list of their various PHEV trial experiences, then asked to rank how influential each experience was to their assessment of the vehicle (detailed in Section 3.5.5). For illustration, Table 9 summarizes Ethel Potter's ranking of experiences. For Ethel, the most influential experiences with the PHEV technology were i) regularly using it to commute to and from work, and ii) a moment where the Prius monitor showed her she had achieved 89 miles per gallon for a given trip. Her most influential social experience, which was ranked on par with the two technology experiences just noted, was talking with one of her daughters that was enthusiastic and supportive of the PHEV. Her most influential research experience was interview #2, where researchers first dropped off the PHEV and explained the technology. At the bottom of Table 9 are experiences she ranked as having little influence over her PHEV assessment, such as refueling the PHEV, telling two uninterested coworkers about her PHEV trial, and reading the "PHEVs Buyers' Guide" for the online survey.

Figure 27 summarizes the distribution of rankings across all 10 primary households. Seven households ranked at least one social interaction as being highly influential, and nine ranked at least one as being moderately influential. The one household that ranked all social interactions as having low influence was the McAdams. As I'll explore further in Chapter 5, the McAdams' do believe that social influence does occur—but it just didn't occur during their PHEV trial. The McAdams' are Toyota Prius owners immersed in a social network of fellow HEV and Prius owners, and their trial of a converted Prius did not generate much novel discussion. However, they readily admit that social interactions played an important role in their and their friends' purchases of HEVs in the past.

Table 9: Ethel Potter's Ranking of Socio-Technical Experiences

Rank	Type of Experience		
	Technology	Social (talking with…)	Research
More influential experiences			
9-10	• Driving to/from work • Getting 89 mpg	• Daughter 1	• Interview #2
8-9	• Initial test drive	• Daughter 2	• Initial phone call • Interview #4
7-8	• Driving to/from Grass Valley • Driving to run errands	• Irrigation repairman • Husband	• Interview #3
6-7	• Comparing MPG with the fleet	• Coworker 1 • Boss • Daughter 3 • Pottery teacher • Sister	
5-6	• Watching mpg reading • Watching Prius monitor	• Daughter 4 • Pottery student	• Interview #1
4-5	• Visiting V2Green website • Using only the battery on highway	• Daughter 5 • Friend 1 • Solar panel salesman	
3-4	• Plugging in at home • Watching the battery deplete	• Daughter's boyfriend • Son	
2-3	• Refueling the PHEV	• Friend 2 • Daughter 6	• Invitation letter • Online survey part 1
1-2		• Friend 3 • Coworker 2 • Friend • Church Guy • Coworker 3	• Online survey part 2 • PHEV Buyers' Guide
0-1			
Less influential experiences			

Figure 27: Primary household's ranked influence of their PHEV trial experiences over their PHEV assessment



The comparison in Figure 27 does not seek to tally up experiences from each category to determine a "winner," but is instead provided to yield one answer to my first research question. The high ranking of at least some social interactions across the majority of social networks in this study suggest that indeed, social interactions can play a significant role in participants' assessment of PHEVs. In a sense, this result is a "proof of existence," providing an initial justification for conducting social influence research in the first place.

4.4 Under what conditions do social interactions matter?

I now start to explore why some social interactions are ranked as more influential than others. To look for patterns among the 275 reported interactions, I view distributions and employ simple statistical analyses. To guide this exploration, I consider five categories of characteristics that may explain why some interactions are more influential, including:

1. The relationship between the primary household and alter, including role category, social proximity and tendency to discuss vehicles.
2. The mode of the interaction, including face-to-face (verbal or non-verbal), phone, or electronic, e.g. e-mail, instant messaging or online social networking.
3. The types of PHEV benefits or attributes addressed in the interaction (private vs. societal and functional vs. symbolic, as discussed in Section 1.4).
4. Experience with alternative-fuel technology on the part of the primary household and the alter.
5. The presence or absence of pro-environmental values for the primary participant and the alter.

I constructed a database of the 275 reported social interactions, and used interview data to code each interaction according to these five types of characteristics. Distributions of these characteristics are depicted in Table 10. Two types of statistical analysis were employed to look for patterns among these characteristics. Two-way tests of independence were conducted to look for association between the ranked influence of an interaction (three levels: high, moderate, or low influence) and the characteristic in question. Ordinal logistic regressions were also estimated to consider multiple explanatory factors, with ranked influence as the dependent variable (three levels: 0 = low influence, 1 = moderate influence, 2 = high influence). The first logistic regression model in Table 11 includes all factors, while the reduced model only includes statistically significant categories. Each factor is explained below:

Relation with alter: I considered three measures of relations between the primary household and alter. First is the role category, including family, friend, coworker, neighbor or other. Across the 275 reported interactions, I find no evidence of association between the alter's role category and the ranked influence of the social interaction.

A second measure of relation is whether the primary and alter typically discuss vehicle purchases. When primary households constructed their sociograms in Interview #2, they were asked to identify alters they had talked to regarding a previous vehicle purchase, alters they might talk to regarding a future vehicle purchase, and alters that would likely talk to them in such a situation (see Figure 17). I categorize the 63 reported social interactions with these alters as occurring with "typical vehicle discussants." A two-way test of independence between this category and ranked interaction influence suggests there is no association ($X^2 = 1.594$, $df = 2$, $p\text{-}value = 0.45$), which is supported by regression results.

Table 10: Characteristics of social interactions (n = 275)

Factor (reference)		Number	Percent
1) Relation with alter			
Role category	Family	49	17.8%
	Friend	84	30.5%
	Coworker	85	30.9%
	Neighbor	18	6.5%
	Other	39	14.2%
Typical vehicle discussant	Yes	63	22.9%
	No	212	77.1%
Social proximity	Very close	89	32.7%
	Somewhat close	87	31.6%
	Casual Acquaintance	75	27.3%
	Stranger	23	8.4%
2) Mode of interaction	Face-to-face verbal	250	90.9%
	Face-to-face non-verbal	7	2.5%
	Phone	10	3.6%
	Electronic	8	2.9%
3) PHEV benefits discussed			
Private vs. societal	Private	241	87.6%
	Societal	34	12.4%
Functional vs. symbolic	Functional	258	93.8%
	Symbolic	17	6.2%
4) Alt-fuel experience			
Primary owns HEV	Yes	57	20.7%
	No	218	79.3%
Alter has alt-fuel experience	Yes	22	8.0%
	No	253	92.0%
5) Pro-environmental values			
Demonstrated by primary	Yes	110	40.0%
	No	165	60.0%
Reported for alter	Yes	22	8.0%
	No	253	92.0%

Table 11: Logistic regression predicting ranked influence of interactions

	Full Model		Reduced Model	
Factor (reference)	Estimate	SE	Estimate	SE
Intercept 1	0.11	0.92	0.67	0.40
Intercept 2	1.58	0.93	2.05	**0.42****
Relation with alter				
Role Category (family)				
Friend	-0.44	0.22		
Coworker	-0.26	0.28		
Neighbor	0.22	0.39		
Other	-0.09	0.36		
Typical vehicle discussant	-0.13	0.20		
Proximity (very close)				
Somewhat close	-0.54	**0.23***	-0.51	**0.17****
Casual	-0.80	**0.27****	-0.77	**0.19****
Stranger	-0.73	0.38	-0.59	**0.28***
Mode of interaction (FTF verbal)				
FTF non-verbal	-0.24	0.53		
Phone	-0.31	0.37		
Electronic	0.82	**0.38***		
PHEV benefits discussed				
Societal (private)	0.90	**0.38***	1.15	**0.22****
Symbolic (functional)	0.34	0.34		
Alt-fuel experience				
Primary owns HEV	-0.87	**0.33****	-0.95	**0.24****
Alter has alt-fuel experience	0.74	**0.28****	1.01	**0.25****
Environmental values				
Primary	-0.22	0.20		
Primary * societal	0.20	0.51		
Alter	0.20	0.46		
Alter * societal	0.47	0.66		
r-square	0.205		0.170	
Log-likelihood	-194.03		-202.38	

* $p < 0.05$ ** $p < 0.01$

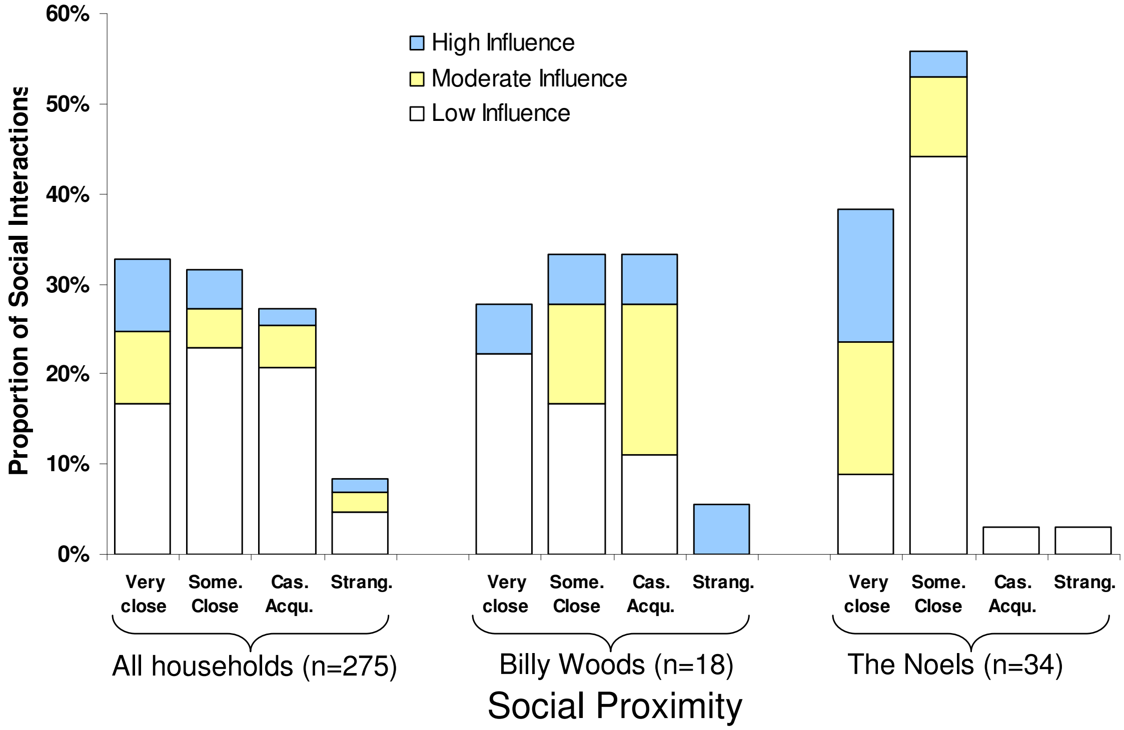
The third relational measure is social proximity, which I employed in construction of the primary households' sociograms. This factor is found to be statistically significant in the logistic regression, as well as a two-way test of independence ($X^2 = 16.91$, $df = 6$, $p\text{-}value < 0.01$). Interestingly, the standardized residuals in Table 12 indicate the relationship may not be linear; interactions with very close alters and strangers may have been more influential, while interactions with somewhat close alters and casual acquaintances may have been less influential. Figure 31 visually depicts this relationship for all primary households, and illustrates differences among households with two examples. Billy

Woods' (recreation-oriented lifestyle) most influential social interactions took place with alters from each category of social proximity, including several casual acquaintances and one stranger. In contrast, the Noels (family-oriented lifestyle) only ranked interactions with very close or somewhat close alters to have high or moderate influence—particularly the very close alters. The non-linear association depicted in Table 12 may be a product of aggregating such differing patterns across households—qualitative exploration (in later chapters) will shed further light on these patterns.

Table 12: Contingency table of rated influence by social proximity (standardized residuals in brackets)

	Ranked Influence			
Social Proximity	High	Moderate	Low	Total
Very close	22 (**2.81**)	22 (1.52)	46 (**-3.39**)	90
Somewhat close	12 (-0.57)	12 (-1.57)	63 (1.73)	87
Casual acquaintance	5 (**-2.51**)	13 (-0.50)	57 (**2.32**)	75
Stranger	4 (0.24)	6 (0.87)	13 (-0.90)	23
Total	43	53	179	275

Figure 28 Ranked interaction influence by social proximity



Mode of Interaction: Of the 275 recorded interactions, the vast majority involved face-to-face verbal communication (91 percent). Seven interactions involved face-to-face non-verbal communication, such as a friendly wave on the highway, a jogger's look of surprise, and a neighbor's hand motion indicating the PHEV looked expensive. 10 interactions were based on phone calls, and eight involved electronic forms of communication, including e-mail, instant messaging, and in one instance a PHEV-related posting on Facebook (an on-line social networking tool). I find no statistical evidence of association between the mode of interaction and ranked influence.

PHEV attributes discussed: Considering the typology of potential PHEV benefits in discussed in Section 1.4 and depicted in Table 2, I categorized the interactions reported by participants according to whether they discussed PHEV benefits that were private or societal, and functional or symbolic. Billy Woods provides examples of interactions for each category, where in different contexts he discussed the PHEV's: ability to reduce fuel costs (private-functional), tendency to be perceived as unattractive at nightclubs (private-symbolic), ability to help the environment (societal-functional), and link to a broader vision of alternative-fuel mobility (societal-symbolic). Across households, the vast majority of reported interactions focused on private (88 percent) and functional (94 percent) aspects of the PHEV technology. Two-way tests of independence suggest that interactions are more likely to be ranked as more influential if societal benefits were discussed rather than just private benefits ($X^2 = 38.51$, $df = 2$, $p\text{-}value < 0.0001$), and if symbolic benefits were discussed rather than just functional benefits ($X^2 = 25.69$, $df = 2$, $p\text{-}value < 0.0001$). However, the logistic regression indicates that the discussion of symbolic benefits becomes insignificant when controlling for other factors.

Alternative-fuel vehicle experience: I considered two measures of alternative-fuel experience that might relate to social influence. First is whether the primary household owns an HEV, which accounts for 57 social interactions (in the Rhodes' and McAdams' social networks). Second is whether the alter has previous alternative-fuel experience (accounting for 22 social interactions), including current or previous HEV ownership, building their own EV, or other demonstrated interest and knowledge in alternative-energy issues, such as membership in related social groups. Both factors are statistically significant, where social interactions are more likely to be ranked as influential if the primary household does not own an HEV, and if the alter has some alternative-fuel experience.

Pro-environmental values: I also consider whether the primary household or alter demonstrate pro-environmental values, though neither factor is statistically associated with ranked social influence. This factor is also found to be insignificant if interacted with the pro-societal content factor.

4.5 Discussion of empirical findings

This empirical exploration yields insights that help guide further analysis and future research. In the context of the PHEV demonstration project, social proximity appears to be a more useful measure of influence, and means of constructing a social network, than role categories (friend, family, etc.) or a list of typical vehicle discussants. Interestingly, the number of identified socially close alters does not necessarily correspond to the number of social interactions that occur during the PHEV trial—a substantial portion of interactions occur with casual acquaintances and strangers in some households. Because social interactions can occur at any level of social proximity, it may be difficult or impossible to map out a complete relevant network *a priori*. Thus, the present study's broad definition of social network (social proximity) proved useful, allowing participants to scale up their sociogram as interactions arose during their PHEV trial. These results also illustrate the significant heterogeneity in social network composition and social interaction patterns among primary households. Personal social networks defined by social proximity can vary substantially in the number of alters and their distribution by social proximity.

A primary objective of this dissertation is to determine if social interactions are worth studying at all. I find that in the context of participants' PHEV assessment, social interactions generally do matter; most primary households ranked at least one social interaction as being highly influential over their assessment of the PHEV technology. Thus, the assessment of PHEV technology does not occur in isolation—participants often interact with others to form their own interpretations about functional, symbolic and societal benefits. Further, this methodology suggests that participants are also aware of social influence processes to some degree, supporting the notion that social influence researchers can consult participants directly.

I also looked for patterns to help explain the heterogeneity of social interactions' ranked influence. In pooling the interactions observed across primary households, I find statistical evidence for three important factors: the discussion of societal PHEV benefits, the alternative-fuel expertise of the primary household and alter, and the social proximity between the primary household and the alter. First, interactions that involve discussion of societal PHEV benefits tend to be ranked as more influential on the primary household's evaluation of the PHEV. This finding supports later theoretical discussions (Chapters 5-7) that the adoption of new vehicle technologies is not just driven by the diffusion of functional information, but also by the interpersonal negotiation of societal benefits. Although I do not find evidence of importance for discussions of symbolic benefits, I note that this category is difficult to measure—a participant's perceptions of symbolic meanings often occur upon reflection of several interactions, or from a general sense of social norms rather than particular interactions. The present methodological focus on specific social interactions may thus be insufficient to detect the role of symbolic discussions, whereas Heffner et al.'s (2007) focus on HEV owners' general perceptions of symbolic denotations proved more effective.

Another factor of importance is alternative-fuel experience. Households that already own an HEV tend to rank social interactions as less influential than those that don't—likely because they had already formed functional, symbolic and societal perceptions of electric-drive technology prior to their participation in their PHEV trial. On the other hand, interactions with alters that have alternative-fuel experience or knowledge tend to be ranked as more influential by primary households. Thus, we find evidence that patterns of social influence may depend on the relevant experience, or lack thereof, between the participants in a social interaction. This finding supports elements of the diffusion of innovations (DOI) approach described in Section 2.3.1—postulating that influential information is more likely to flow from more experienced individuals, e.g. innovators, to those with less experience. Functional expertise and the flow of functional information are relevant concepts that are discussed further in the next chapters.

A third factor of importance is social proximity, which exhibits a non-linear relationship with social influence in this sample. On the one hand, as conventional wisdom might suggest, interactions with very close alters are more likely to be rated as influential. On the other hand, interactions with strangers also tend to be ranked as more influential than those with somewhat close alters and casual acquaintances. One explanation may be that my analysis inappropriately compiles interactions from different types of social networks, such as those that tend to interact with and draw influence from closer alters, e.g. a tightly-knit family like the Noels, and those that tend to do so with more socially distant alters, e.g. a single man engaging in multiple recreational activities like Billy Woods. The small sample size of the present research makes it difficult to assess consistency of such patterns, but future research may explore how different network types are influenced by social proximity.

Taken together, this Chapter has taken a birds-eye view of the data collected in this study. I have depicted distributions of participant and social network characteristics and pooled observed social interactions to perform an initial search for patterns. This stage of analysis has proved useful: demonstrating the effectiveness and limitations of research instruments, portraying the variety of household patterns, and identifying some early clues to help characterize processes of social interaction. This analysis has also helped to illustrate its own weaknesses. Most importantly, by pooling observations I ignore the in-depth narrative data I have collected from each household and social network, and neglect the uniqueness of each context. For example, the unclear relationship between social proximity and ranked influence likely results from heterogeneity in household interaction patterns—that is, the uniqueness of each household's social behavior and lifestyle practices. Thus, I should be careful about interpreting this statistical relationship and any other I have explored here. Although pro-societal content is generally ranked as more influential, I should (and will) explore this on a case-by-case (and narrative by narrative) basis to seek out a more elaborate understanding of social influence process. I shall be similarly careful with the identified pattern of electric-drive expertise. Further, in-depth case analysis may help identify important factors and themes that are not so easily quantified and were thus omitted in the above exploration. But at the very least, this Chapter has provided a useful overview to help guide the next steps of this analysis.

5 Applying Five Perspectives on Interpersonal Influence

Chapter 4 provides interesting overviews of some general patterns of social interaction, and provides an affirmative response to my first research question: does social influence matter? However, the purely quantitative overview and analysis necessarily excludes many of the important details collected in this research design. Now I review the narratives I constructed for each primary household and social network in order to revisit the five perspectives on interpersonal influence reviewed in Chapter 2: contagion, conformity, dissemination, translation and reflexivity. I apply each research perspective to qualitative interview data collected from participants in each of the 11 social networks. I return to my second research question: how can we characterize the interpersonal processes that impact consumer perceptions of functional, symbolic and pro-societal attributes? In light of the five perspectives reviewed in Chapter 2, this question can be rephrased as: how does each perspective characterize the social interactions that influence consumer perceptions of functional, symbolic, and pro-societal PHEV attributes? In comparing these perspectives, I seek to identify which of these perspectives are most realistic and useful in regards to advancing research in transportation behavior.

5.1 Household stories: Three patterns of social influence

One starting point for differentiation among these interactions is the networks themselves. The previous chapter statistically identified two types of factors that are associated with the rated influence of a given social interaction: experience with electric-drive vehicles and discussion of pro-societal benefits. I use these factors to divide the 11 networks into three basic categories, as summarized in Table 13. The first two categories consist of households that have little or no experience with electric-drive vehicles (EVs, HEVs or PHEVs) prior to their participation in the PHEV trial. Several of these households spent the bulk of their trial trying to learn about the functional aspects of the PHEV. However, these two categories are distinguished by the values and lifestyle patterns exhibited by the primary household: those in the first category are primarily interested in private values and lifestyle practices, while those in the second category are open to the exploration of societal, e.g. pro-environmental or pro-national, values and lifestyle practices. The third category consists of two household who own HEVs, i.e. they are experienced with and interested in electric-drive, and also demonstrate a strong commitment to pro-societal values. Before applying the five perspectives on social influence, I first illustrate each of the three categories with a brief story of one household (more elaborate narratives are provided in Chapter 6).[12]

[12] In the present sample, I did not observe any households that could be classified as being both electric-drive enthusiasts and only motivated by private values. Such a combination appears to be rare in the current vehicle market, though some may currently exist, and more may exist in the future. However, I leave such speculation to future research.

Table 13: Summary of primary households and secondary participants

Primary HH information (example household in **bold**)	Total close alters	Total social interactions w/ close alters	Total social interactions
E-drive novices with private lifestyle			
The Noels:	101	29	34
The Petrovs:	26	15	26
Betty Earhart:	24	6	17
The Stashs:	46	14	30
Melissa Stash:	42	16	20
E-drive novices exploring pro-societal lifestyle			
Billy Woods:	44	11	18
The Rancheros[1]:	26	13	15 (20)
Ethel Potter	36	18	24
The Forts:	44	15	29
E-drive enthusiasts with pro-societal lifestyle			
The McAdams:	50	14	31
The Rhodes:	49	23	26

[1] A sociogram was elicited from Ed Ranchero only. "Total social ihnteractions" value in brackets includes five additional interactions reported by Silvia Ranchero.

5.1.1 E-drive novices engaged in private lifestyle: The Noels

Rupert and Amy Noel live with their three young children. They are family-oriented—devoting extensive time to their children and frequently interacting with their large extended family (recording 101 "close" members of their social network in Table 13). 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 friends and coworkers, and he reports that 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 four-year-old daughter's vocabulary. In all their conversations with members of their personal network, the Noels' talked only about what are to them basic private-functional aspects of the PHEVs, such as recharging and fuel savings. The basic functioning of PHEVs was not well understood by the Noels or clearly communicated by them 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 assessed 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.

5.1.2 E-drive novices exploring pro-societal lifestyle: Billy Woods

Billy Woods is recently divorced and lives alone in a detached home. He frequently engages in many social and recreational activities—golfing, skiing, and visiting bars and night clubs. As a self-described "social guy," he discussed the PHEV extensively within his diverse social network (Figure 25), including his technology-oriented coworkers at a computer company. He explored the PHEV's "bells and whistles" with June ("J" in Figure 25), 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 to 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 adopted their private-motivated assessment as part of his own.

5.1.3 E-drive enthusiasts engaged in pro-societal lifestyle: 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 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 to purchase 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.

5.2 Characterizing patterns of social influence

Here I used the above stories and their supporting data to draw out preliminary answers my research questions. As discussed in the Chapter 4, interactions within social networks can play an important role in a household's assessment of a PHEV. Among other things, such interactions included seeking 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. To explore deeper, this section describes interactions from the five perspectives reviewed in Chapter 2: contagion, conformity, dissemination, translation, and reflexivity. Although I only draw from the three example narratives in the following discussion, Table 14 summarizes these perspectives as applied to social influence within each of the ten primary households.

Each section begins with a very brief summary of the perspective—see Section 2.3 for more details.

5.2.1 Contagion

Contagion views social influence as the result of a primarily unidirectional flow of functional information, that is, information about what the PHEV can physically do. For example, Billy Woods frequently informed people he was driving a PHEV and would briefly explain that it was different from a regular Toyota Prius—in these interactions he was spreading functional information from himself, the relative expert, to others. In another example, Rupert Noel told his work supervisor, John (in Table 7), that the PHEV had reasonable acceleration capabilities; John later explained "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. Most households exhibited several instances of this pattern, mainly when they were "showing off" or sharing a particularly simple piece of information about the vehicle, e.g. that it plugs in, or gets good gas mileage.

However, the contagion perspective neglects many subtle but important nuances of interpersonal influence. One important criticism arising from this research is that functional information is not all that is shared during social interactions. Indeed, Billy

Woods did use several social interactions to inform his own functional perceptions of the PHEV, such as experimenting with the Prius monitor with June. 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 or spreading functional information about PHEV technology, but rather was testing how a certain perspective and lifestyle might fit in with one of his reference groups. Perhaps most importantly, the social interactions that best classified as diffusion, e.g. are limited to the one-way passing of functional information, tend to be ranked by the primary household as being less influential over their overall PHEV assessment, such as Billy Wood's and Rupert Noel's descriptions and dismissal of non-influential "small talk."

A further criticism of the diffusion perspective is the limiting assumption of unidirectional information flow from experts or innovators toward the remaining majority. Testimony from Billy, an electric-drive novice, and Harry, an electric-drive enthusiast, indicate that their exchange was clearly bi-directional—each of them pulled different types of information away from the experience. Similarly, while it may be tempting to label the McAdams as electric-drive "innovators," even they describe learning from and exchanging information with others (and others who are not "innovators") on an ongoing basis. Primary households and their alters 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 own history and background knowledge. Thus, diffusion and contagion research perspectives may be unnecessarily limiting and unable to capture the full complexity of interpersonal influence.

5.2.2 Conformity

Conformity views social influence as derived from an individual's perceptions of what others are doing and what others think is desirable. 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 visually 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.[13] 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.

5.2.3 Dissemination

Dissemination is the intentional diffusion of information from an organized group of individuals that are dedicated to the achievement of pro-societal benefits. 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 as I define it—they appear to be a reaction to the functional novelty of the PHEV trial, and did not include reference to any pro-societal benefits.

---

[13] The Jetsons© was a futuristic cartoon television show in the US first produced in the 1960s.

However, the McAdams described themselves as advocates for electric-drive technology. 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…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 vehicle technology 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—that is, how did the McAdams become dedicated to pro-societal values in the first place?

5.2.4 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. helping the environment. This dialogue helped Billy to solidify his interpretation of the PHEV as a 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.

5.2.5 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 explains that lifestyle trajectories are not static for an individual, but like interpretations are constructed, shared, and negotiated over time.

The visibility 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 *liminality* (characterized by ambiguity, openness and indeterminacy, as introduced in Section 2.3.5 using Turner's (1969) terminology), 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. The importance of these factors can be illustrated with the three households introduced above.

Table 14: Characterizing interpersonal interactions for each primary household

	Approach:				
Network:	Contagion	Conformity	Dissemination	Translation	Reflexivity
E-drive novices with private lifestyle					
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 want 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.
The Stashs	Telling others about their PHEV trial.	Perceiving that others also valued fuel savings and practicality above all else.	None observed.	Interpretive flexibility: focusing on the economic savings of the PHEV, Darren was unable to conclude whether it would actually save him money overall.	As an engineer, Darren's trial is an opportunity to rationally assess the financial and functional performance of a new technology. Though peers are like-minded, their lack of interest in the PHEV subdues his own initial excitement—his assessment remains incomplete.
Melissa Stash	Telling others about her PHEV trial.	Perceiving that most friends are not interested in the PHEV.	None observed.	Interpretive flexibility: unsure of how to value the vehicle altogether.	As a young college student, Melissa excitedly shows novel PHEV features to her friends. She has little experience with energy costs, but after talking with a more experienced friend, begins to link the PHEV to a more responsible lifestyle: adulthood.
E-drive novices exploring pro-societal lifestyle					
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.

(Continued on next page)

Table 14B: Characterizing interpersonal interactions for each primary household (continued)

Network:	Approach: Contagion	Conformity	Dissemination	Translation	Reflexivity
The Rancheros	Telling coworkers how 80% of CO_2 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 people in 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. Inspired by her trial, she subsequently increased her commitment to environmental practices, such as scheduling home installation of solar panels.
The Forts	Telling coworkers that the PHEV was great on gas.	Perceiving that coworkers value the technology, neighbors value big vehicles, and "green" people value environment.	None observed.	Interpretive flexibility: reasoning that the PHEV was good for the environment and had a long financial payback period—but unsure whether environmental or financial benefits were more important.	As a tight family unit, the Forts frequently consult one another about decisions. Without strong loyalty to outside groups, they can freely consider and experiment with different—and often contradictory—lifestyle practices such as off-roading and environmentalism.
E-drive enthusiasts with pro-societal lifestyle					
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 a PHEV is just another stage of the trajectory—supporting further production of electric-drive vehicles, 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

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 had recently shifted to a liminal state. 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 used 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 technology 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 years, Brian was already an electric-drive "expert," and the McAdams had already constructed and become integrated within a social 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.

5.3 Discussion

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.

The perspective afforded by Giddens' "reflexive project of the self" 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 or easily come to a basic understanding of functional aspects of PHEV technology, and iii) find supportive pro-societal values within their social network. Themes derived from exploration can guide future 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.

In order to explore the third primary research question for this dissertation, the next chapter utilizes the reflexivity perspective to produce even more in-depth analyses of four household narratives.

6 The Spread of Pro-Societal Values: Narrative Analysis

To explore my third research question, this Chapter focuses in more depth on findings discussed in the previous chapter. Chapter 5 viewed the ten households from the five perspectives outlined in Chapter 2, that is, *contagion*, *conformity*, *dissemination*, *translation* and *reflexivity*, to the social networks observed in this study. I concluded that the translation and reflexivity perspectives proved better able to account for the complexity of social influence processes than the diffusion, conformity or dissemination perspectives alone. Translation represents how individuals may progress from a state of *interpretive flexibility* to a state of *interpretive closure* in part though negotiation among relevant social groups. Reflexivity looks in more depth at the context and motives of the individual who seeks to organize their past, present and future into a meaningful lifestyle trajectory—a process that also takes place in part through social interactions and negotiations within and among social groups which are themselves dynamic.

In Chapter 5 I began to illustrate how the reflexivity perspective helps identify conditions that may support an individual's adoption of pro-societal values. I noted three such conditions: i) the *liminality* of the household's current lifestyle practices, e.g., whether they are in a state of transition or openness in regards to their self-concept (as summarized from Turner (1969) in Section 2.3.5), 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. In this chapter I further explore these conditions for each social network observed in this study. I place particular emphasis on those in the second of the three categories I identified in the Chapter 5, people who are e-drive novices but who are otherwise exploring pro-societal lifestyles—what I will call the "pro-societal explorers." The categorization of all 11 social networks is depicted in Table 15.

Table 15: Three patterns of interpersonal influence in social networks

	Lifestyle		Functional understanding of e-drive		Pro-societal values	
Primary HH (**example**)	Practices	Liminality	Already familiar?	Easily learn PHEV?	Initial interest?	Support from network?
E-drive novices, "private lifestyle"						
The Noels:	Family	Low	No	No	No	No
The Petrovs:	Construction/ family	Mod	No	No	Some-what	No
Betty Earhart:	Work	Mod	No	Yes	No	No
The Stashes:	Work/family	Low	No	Yes	No	No
Melissa Stashe:	Student	High	No	No	No	No
E-drive novices, " pro-societal explorers"						
Billy Woods:	Recreation/social	High	No	Yes	Yes	No
The Rancheros:	Family/technology	Mod	Yes	Yes	Yes	No
Ethel Potter	Family	High	No	Yes	Yes	Yes
The Forts:	Family/recreation	High	No	Yes	Yes	Yes
E-drive enthusiasts, "pro-societal lifestyle"						
The McAdams:	Enviroment/technology/social	Low	Yes	Yes	Yes	Yes
The Rhodes:	Family/enviroment/technology	Low	Yes	Yes	Yes	Yes

For each primary household, my qualitative assessment of each condition is based on multiple factors—ultimately I use my judgment using everything I have learned about the household. Liminality is based on how open the household was to consider self-concepts and lifestyle practices that differed from their status quo, as well as their flexibility and ability to implement such practices. More liminal households tended to have less commitments and responsibilities, e.g. no young children, less routines, e.g. a flexible work schedule, more abundant resources, e.g. time and money, and social connections with and exposure to social groups with a variety of perspectives. I assessed functional understanding based on the household's demonstrated ability to learn about and articulate their perceptions of PHEV benefits at various points during their PHEV trial. Finally, I assessed network support based on the household's description of the social values of their alters, and the support (or lack of support) demonstrated in social interactions. (Future research will need to articulate more concrete definitions of each of these conditions).

Considering these three conditions, I first briefly summarize the narratives of each of the "private lifestyle" networks (the first category), and the "pro-societal lifestyle" networks (the third category). Then I portray full-length narratives as "thick" description (Geertz, 1973) of the four "pro-societal explorer" households, that is: Bill Woods, the Rancheros, Ethel Potter and the Forts. While all four households actively considered and experimented with pro-societal values and lifestyle practices during their PHEV trial, by the end two maintained primarily private interpretations of the PHEV, while the other two settled on pro-societal interpretations. In an effort to help understand why different household contexts led to different results, each narrative is an integrative storyline of the primary household's background, PHEV trial experience and final assessment of PHEV technology. The perspectives of secondary participants are also portrayed in side boxes, which yield additional information about the primary household, their social interaction patterns, and the alters in their social network. To construct each full length primary narrative and the mini secondary perspectives, I draw from all data collected from the employed methodology, including in-person interviews with primary households, social episode diaries, online surveys, phone interviews with secondary participants, and vehicle use information.

6.1 Social networks that emphasize private values

The Noels, the Petrovs, Betty Earhart and the Stashes each began and ended their PHEV trial with private interpretations of the PHEV, and lived private lifestyle practices and values in general. In Chapter 5, I explained that the Noels are committed to a family-oriented lifestyle which includes regular interactions with their three young children and an abundance of close family members. The Noels began their trial without any electric-drive familiarity, and did not encounter any electric-drive experts over their course of their trial. Because the Noels are not generally technology-savvy, they struggled to understand the basic functions of the PHEV, such as the potential to reduce trips to the gas station, and had little understanding of potential societal impacts. The Noels, their recruited secondary participants and their other alters are not interested in pro-societal values or environmental practices, and in reported instances they did not discuss or seriously consider pro-societal benefits of the PHEV. With a committed private lifestyle, little functional understanding of the vehicle and a lack of pro-societal support in their network, the Noels are not likely to develop pro-societal interpretation of the PHEV.

As a household, the Petrovs are in a slightly higher state of lifestyle liminality than the Noels. Adam Petrov is a retired maintenance supervisor in his sixties who spends most of time on handy-man "small jobs" for friends and acquaintances—he primarily assessed the PHEV based on functional practicality. However, his younger wife Katrina is a recent immigrant and current college student, and was initially open to a wide array of potential interpretations for the PHEV, including environmental implications. Neither of the Petrovs have prior experience with electric-drive. Although Adam is used to assessing new handyman tools and technologies, he has difficulty understanding the PHEV's functions and consistently miscalculates its battery usage and fuel economy, while Katrina perceives Adam as a relative expertise and defers to his judgment about the vehicle's performance. The Petrovs are surprised to find the PHEV stimulates little interest in their social network, and any conversations that arose mainly addressed functional benefits such as fuel economy and handling. Katrina engaged in one social interaction with a school friend that linked the PHEV to her home country, and how the Soviet Union had experimented with electric vehicles. By the end of their trial the Petrovs had neither the functional understanding nor pro-societal interest to seriously consider or adopt pro-societal interpretations of the PHEV.

Betty Earhart is a business-oriented woman who spent most of her life on the east coast before moving to California. Though Betty's life was in a transitional state—she recently broke up with a boyfriend, was temporarily living with a friend, and her daughter recently moved out of state—she was working to return her lifestyle to normal and was not considering new or different lifestyle practices. As a bright, computer-savvy worker, Betty was quick to understand the functional benefits of the PHEV despite her lack of previous electric-drive experience. However, she had no interest in pro-societal aspect of the vehicle; she did not once mention pro-societal benefits in social interactions or during interviews, and she could identify only one alter that might be interested in environmental issues in general. The vast majority of Betty's alters, like herself, were mostly interested in the PHEV's practicality and fuel savings potential if they were interested at all.

Darren and Pat Stashe are also firmly entrenched in their private values—they explain that a vehicle should be practical and "utilitarian" like Darren's pickup truck, and they would only buy an electric-drive vehicle if it could save them money. As an engineer familiar with the electricity grid, Darren easily understands the PHEV's functions, and intended to use his PHEV trial as an opportunity to assess its functional and financial performance. However, like the Petrovs, he is disappointed to discover a lack of interest among his friends, coworkers and acquaintances, and gradually loses interest in his own assessment. The Stashes indirectly encounter one individual with pro-societal values—a neighbor explained how her husband bought his Prius to be "green." The Stashes thought this motivation was interesting, but did not relate it to their own interests.

The Stashe's college student daughter, Melissa, had fewer preconceptions about the PHEV, and had a difficult time understanding its functional benefits. Initially, Melissa would show off the Prius' keyless entry to her friends, but soon found that most were not particularly interested in the vehicle—some even laughed and referred to a recent television satire labeling the Prius a "smug" car. However, she talked to several older friends who were more genuinely interested in the PHEV. Although she identified such conversations as influential, she could not articulate what benefits were important to herself or these friends, and she generally deferred to her father's interest in financial savings.

6.2 Social networks that emphasize pro-societal values

Chapter 5 also described the McAdams as a household that maintained a dedication to pro-societal values throughout their PHEV trial. Their lifestyle is not presently liminal—many of their practices are anchored around these values, and integrated within a social network of like-minded alters. The McAdams already owned an HEV and had previously researched PHEV conversions, and were thus quick to understand their trial vehicle. However, the McAdams were not always so fully engaged in this lifestyle. They became increasingly interested in pro-societal issues several years ago when they moved to Davis, a small California city known for environmental values, to attend University. As they became increasingly immersed in the local community, and as their household income increased as Craig finished school, the McAdams became strongly interested in pro-societal issues, technologies and practices.

The Larry and Cheryl Rhode exemplified a similar pattern as the McAdams: as "tree huggers" that have been dedicated to pro-societal practices for many years, such values are well integrated into their lifestyle and social network. They practice organic gardening, use only compact fluorescent light bulbs, and send their son to a preschool that espouses environmental values and includes special classes on environmentally-friendly technologies. Larry Rhode owns a Honda Civic HEV, and routinely researches alternative fuel vehicles and energy technologies, such as EVs and bio-diesel cars. Larry frequently talks to others his HEVs and the PHEV during his trial, in efforts of “getting the word out” about such technologies. Within his network he encounters alters that had already researched a PHEV conversion for their own Prius. Cheryl also felt that the PHEV fit with her pro-societal values, and driving the car helped her feel like she fit in better in certain social situations, such as when parking at their local pro-environmental grocery store.

6.3 Narrative accounts of social networks exploring pro-societal values

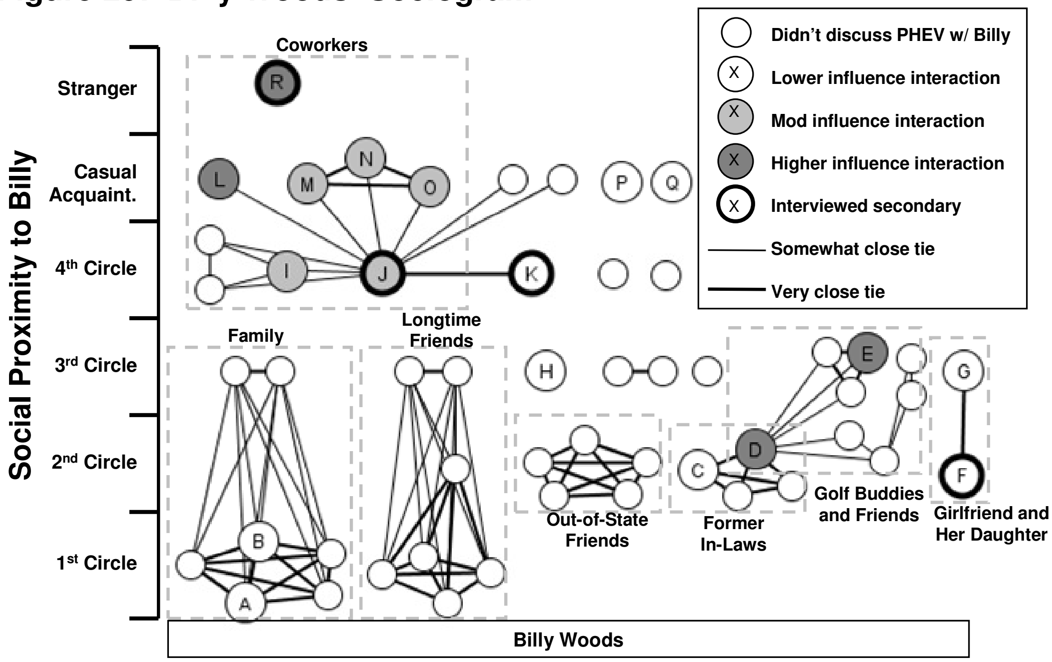
I now turn to the “pro-societal explorer” category of social networks: those that actively considered shifting their values from a private to pro-societal focus during their PHEV trial. I begin Billy’s Woods story (depicted here in more detail than in the previous chapter), followed by narratives of the Rancheros, Betty Potter and the Forts. For each household I construct the narrative according to the five main components outlined in Section 3.5.6, including: i) a goal state (the PHEV assessment), ii) events related to the goal state (participant experiences), iii) chronological arrangement of events (background, then trial experience, then PHEV assessment), iv) logical/causal flow between events, and v) demarcation signs indicating the stage of the story. For each social network, I also include shorter narratives elicited from their secondary participants in side boxes to provide additional perspectives on their PHEV trial (except for the Rancheros, who were unable to recruit any secondary participants).

6.3.1 Billy Woods: Trying on a new lifestyle

The beginning: A bachelor lifestyle

Billy is a single man in his mid-forties living alone in a detached home in Sacramento. After an “amicable” divorce a couple of years ago, Billy’s bachelor lifestyle is suggested by his décor: a surfboard in the backyard; a dining room dominated by a large putting green, a counter-mounted wine opener and liquor dispenser; and a living room with a large flat-screen TV. Billy describes himself as a social guy who will typically “make friends pretty easy,” and he identified 44 alters in his social network (Figure 29). He completed an undergraduate degree in civil engineering, a Master’s in environmental management, and an MBA, and he currently earns a six-figure income as a public relations person at a computer company. He owns a 1995 Lexus ES 300 which he bought used from his sister and currently uses for commuting—although he often works from home—as well as an older pickup truck he occasionally uses on weekends, and what he considers to be a small Harley Davidson motorcycle. Billy explains that he particularly likes trucks because they are stylish, practical for hauling, camping and moving, and he has experienced their protective capabilities in a high-speed crash (where he was surprised to emerge uninjured).

Figure 29: Billy Woods' Sociogram



Prior to participating in this study, Billy had little familiarity with his current energy expenditures, including gas and electricity use. He also had no previous experience with "electric-drive," not even a Prius, and didn't initially understand the differences between an HEV, PHEV and EV. He expected the PHEV itself to be "sluggish, not to perform like a regular combustion engine." Billy also anticipated that he would talk to many people about the PHEV—when researching something new, he will typically "toss it to other people to see what their thoughts are, if it is worthwhile…some suggestions."

The trial: Showing off, exploring and polling others

Throughout his trial, Billy learned about the PHEV through experiences with the technology itself, as well as through some of his 18 social interactions. At first, Billy would initiate conversations to “show off” the vehicle; he called his **sister (B)** and **Mother (A)** to tell them about the study but discovered his mother had little concept of hybrid vehicles, and his sister was unimpressed that the car was “just a Prius.” During these and other “small talk” conversations, e.g. **co-workers (L-O), bartender (P), hair cutter (Q)**, Billy engaged in a general “intro” pattern, briefly describing the study, how the car was special, and then answering some basic questions. He reported that such interactions didn’t last more than 10 minutes, and usually the alter would not

Box 1: June and Chris’s perspective
PHEVs as a way to be greener

June and her partner, Chris, are in their forties and live together in the Sierra foothills outside Sacramento. Both consider themselves to be very close friends with Billy—June works with Billy and sees him several times per week, Chris plays golf with Billy weekly, and all three occasionally ski together. June and Chris own a 2002 Ford Escape that June uses to commute 38 miles to work, a 2006 Ford Mustang, and a truck that Chris uses for work as a painting contractor. Prior to Billy’s trial, June was only mildly familiar with HEVs, while Chris had been following electric-drive technology for years, and was aware of the Volt and Tesla. However, he had never been in a Prius.

During the trial, June saw Billy about 20 times. On the first day of his trial, Billy had excitedly told her about the car and they experimented with all the “bells and whistles.” June was also with Billy the first time he refueled it, and they were surprised that the fill only took 6 gallons. For June, the “exciting point” was that the vehicle could save a lot of money on gas. In addition, Billy demonstrated that not only could an electric-vehicle be fast enough for normal highway travel (“it didn’t take 5 minutes to get from 0 to 60”), but it could also be easy to plug in at work and at home, and didn’t have to look overly strange.

Chris saw the PHEV once when Billy drove it to the golf course they were playing. Chris found the plug-in feature immediately and saw the extension cord. Chris asked several questions, such as how far the PHEV went on electricity (Billy didn’t know) and what kind of mileage Billy was getting (Billy said around 56 MPG). When June would come home from work after seeing Billy, Chris would probe her for further information, such as if Billy was plugging in at work. Like June, Chris had the impression that Billy liked the PHEV, though he had a different perspective of Billy’s underlying motives: “he’s trying to be greener…and that’s why…he got the motorcycle…I think he was looking for an efficient way to get back and forth to work, to be green…to lower his carbon footprint…less pollution in the air.”

When describing their own interests in PHEV technology, June and Chris highlight three main bring up the topic in subsequent contacts.

Billy also had more meaningful experiences that helped him to learn about the technology. He faithfully substituted the PHEV for his Lexus, commuting to work most weekdays, running errands, and driving to golf on weekends. He quickly concluded that driving the PHEV was "really no different from any other car," except for perhaps being quieter. When it came to performance, Billy "was not disappointed at all" and was impressed with the vehicle's "pick-up" and acceleration capabilities: "it had some power, it could get to speed…just like any other car." However, he noted some drawbacks, such as when his golfing buddy, **Albert (D)** pointed out that at higher speeds, "you can actually hear the engine almost racing…like it was trying

concerns: saving gas, being green, and style. First, June explained that saving gas was "not only saving money, its new technologies and not being dependent on oil companies." Second, Chris links "green" to issues of air pollution and global warming, and admits that electricity is not perfect but at least better than gasoline, while June is less specific in her definition of green. She explains that a cleaner vehicle is one of the best ways for her to be green, because there aren't many other options in their "semi-rural" area—she couldn't take a bus or ride a bike to work. Lastly, both June and Chris note that style is "a factor we look at when we buy a car," and the Prius—particularly the older model—is kind of "funny looking." Thus, while saving gas and the environment are important concerns, they would still prefer a PHEV that is attractive.

Box 2: Pat's perspective
Cost-effective conservation of resources

At the time of Billy's trial, Pat had been dating Billy for several months. She is in her forties and lives in a detached home in Sacramento with her younger daughter. She has a graduate degree works in the field of education. Pat owns one vehicle—a 2001 Chrysler Town and Country "soccer mom" van she bought used—and commutes in this vehicle 7 miles to her workplace. Prior to Billy's trial, Pat was unfamiliar with electric-drive vehicles. She and her daughter were expecting the PHEV to be "one of those little half cars…[or] go carts," but were ultimately surprised that it was a "regular car" of "regular size."

Pat was in contact with Billy several times during his trial. She was the first person he called when the vehicle was dropped off, and she asked about its color. A few days later he picked her up in the PHEV and she was "amazed" at how normal it was. Pat thought it was "fun to see the displays and things, about…the energy use." Over the trial, Billy plugged in at her house on two occasions. She was surprised to see how easy it was to recharge at her home: "[Billy] just backed in to power up…it left some kind of worry."

Billy talked frequently about the PHEV with his coworker and friend, **June (J),** who helped him experiment with many of the Prius' features, such as the Prius monitor. [See the perspective of June and her husband in Box 1.] Billy also spent some time playing with the monitor on his own, and would often watch it to judge the PHEV's state of charge and to see when the vehicle was using gasoline or electricity. However, the displayed information did not impact his driving behavior –"it's like changing the stations on the radio…more entertaining."

Billy plugged in the PHEV as often as he could. He recharged at home almost "every night…just plug it in and go to bed." Although he didn't initially know

and plugged it in and it's good to go…I already had a cord going out there for Christmas lights." Although she rode in the PHEV multiple times during the trial, their weekend trip to Monterey was particularly memorable for her:

> *"(we thought) we might make this whole trip without filling up for gas, and I was like no way …we almost made that whole trip with about 10 gallons of gas…I was amazed…I think we would have made it if he wasn't such a lead foot."*

By the end of Billy's trial, Pat felt that a PHEV would be "useful" because it was "so easy to do." She envisioned that because she didn't drive many miles during the day, she could drive using mainly electricity, which "just seemed to make sense." She explained her concern with gasoline was about avoiding reliance on "countries we don't want to negotiate with," and wanting to leave resources for future generation. However, Pat is also concerned about making a "smart consumer choice":

> *"I wouldn't go buy [a PHEV] just save to the environment because if its going to cost me a third or a quarter more I could probably save the environment in another way… it wouldn't have to be equal, but it would have to be…like a refinance where you use the car…and [over time] you kind of break even with what you spent, then it starts paying more for itself.."*

Pat has never before applied this refinance concept to a vehicle purchase before, but notes she generally considers fuel economy in previous vehicle purchases. During the trial, she recalled talking to friends about how much research would be required to bring down the cost of HEVs and PHEVs "so that people could actually save the environment and be cost effective." Together they wondered how soon it would be that "people would actually buy a hybrid not for environmental reasons but for cost efficiency as well." In all, Pat felt Billy's experience was important in helping her shape her own ideas of how the vehicle could fit into her life: "with seeing the car and how it works, and then thinking how it would be useful in your own life."

he could recharge at work, **June (J)** encouraged him to look more aggressively—he then discovered a special spot reserved for EV recharging and moved his car there after lunch that day. From then on, he plugged in nearly every day at work. Billy also plugged in at his girlfriend **Pat's (F)** house on two occasions.

Throughout his trial, Billy highlighted the PHEV's potential to save money. However, he never made "an entire assessment." He tried to calculate savings based on the cost of filling the tank, but ultimately he couldn't quantify fuel savings beyond the general notion that "it uses a lot less gas." Billy was more comfortable framing fuel savings according to vehicle's range with a full tank, as with his story of a trip to Monterey with **Pat (F)** [see Pat's perspective in Box 2]:

Box 3: Harry's perspective
PHEVs as EVs for average drivers?

Harry is a coworker who had a one-time encounter with Billy during his PHEV trial—they had never met before, and neither anticipates meeting again. Harry is in his forties, lives with his partner in a detached home, and owns a 2005 Porsche Cayenne and 2003 Chevrolet Silverado. Harry is particularly excited to discuss his old Volkswagen Rabbit that he converted into a short-range EV (40 miles max) and uses for commuting the few miles to work and running errands. He has an array of solar panels at his home that generally covers his home electricity use and has occasionally resulted in a negative electricity bill—it was this excess solar generation that first motivated Harry to build an EV so he could "drive with the sun." Harry recharges his EV at work using a provided recharge spot. Not surprisingly, Harry is highly familiar with many forms of electric-drive vehicle and states that if he were to buy an HEV, his primary motive would be that he "likes new technology."

Harry initiated contact with Billy to discuss a potential problem involving the recharge infrastructure they would commonly share at work:

> *"for the longest time I did not meet Billy, I just saw his plug-in hybrid…parked at the parking lot where it's designated for electric vehicles, which is usually an empty parking spot because next to my car nobody ever charges there… and he had an extension cord and plugged it in.…I was hoping I would run into him…then I noticed he has plugged in his Prius to the same outlet as I had plugged in my EV…that was kind of disturbing because depending on when you plug in, and where my car is on the charge cycle you would actually exceed the amperage for that circuit…so I left him a note that said please call me, and he did the very next day…and we got to talk."*

Wanting to prevent blowing the circuit, Harry summarizes the phone call as a "practical discussion"—he explained the problem and Billy briefly explained the study and that he *"just before I went to Monterey, (the tank) was pretty much empty…I thought I could make the entire trip, that's what my vision was on a full tank…didn't quite make it…[but] it was in excess of 400 miles…that was really cool…I felt that I wanted to meet that goal…and I pushed it as much as I can…[it shows] you get more bang for the buck…I don't have to go the gas station as often…that was neat to see, really cool."*

While Billy primarily focused on the "bang for your buck" aspect of fuel saving, he also highlighted a specific conversation with several of his "opinionated" **co-workers (M, N, O)** as particularly influential. After completing part one of the online survey, Billy had become interested in societal motives. He then took this question to his coworkers:

wouldn't have the PHEV much longer. Billy explained that he liked the performance capabilities of the PHEV, and the ability to recharge, but didn't like the way it looked. Harry explained that his EV had a retractable cord, which Billy seemed to think was a better idea than the awkward 50 foot extension cord. Harry didn't discuss much more detail about his EV because he felt Billy wasn't interested in technical details. Harry also wanted to know if Billy was trying to drive the PHEV in a certain way, such as driving "as long as possible in electric mode," but was surprised that Billy "did not try to minimize gasoline mode at all…[that] didn't seem to be his interest.".

To Harry, the PHEV is an electric-drive vehicle that may have better chances for market success than pure EVs. Initially, Harry had been excited about Billy's PHEV, thinking it might be 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." Of the several thousand coworkers at their company, Harry is normally the only one to use the recharge outlets—he was hoping that Billy's car was the beginning of something. However, after their phone conversation Harry realized "we're not there yet."

Harry's interest in the success of electric-drive is primarily driven by desire to move away from gasoline, which he links to two negative impacts: i) "dependence on foreign oil from a political perspective", and ii) pollution, such as unsustainable greenhouse gas emissions, and links to a dirty industry behind combustion engines, such as "oil changes and so forth." Harry doesn't see PHEVs as the ultimate solution to such problems, but thinks they could serve as part of a "transition solution" that reduces dependence on the gasoline engine. He sees Hydrogen as being a potential fuel of the future, particularly if it is produced using solar energy, though he admits it may be "wishful thinking." He adds that biofuels are not likely to be a positive path due to competition with food grade products.

"[I asked them] why would you buy a hybrid? Mainly to protect the environment, or from a consumer standpoint?…and all of them said if it costs less I'll buy it, basically it's all consumer…and that's what I answered on the survey…if it costs less for me as a consumer then I'll think about it…but to buy it just to protect the environment is probably not something I'd do at this time…definitely I'll look at buying something that would have less of an impact on my pocket book more than anything else…we pretty much agreed upon that."

Near the end of his trial, Billy plugged the PHEV into the same circuit that was being used by another coworker, **Harry (R),** that built and drove his own EV (converted from an old Volkswagen Rabbit), which led to a phone conversation between them [see Harry's perspective in Box 3]. Billy was impressed that Harry's EV had a retractable cord, which made him think that manually coiling the PHEV extension cord was a bit "hokey" and vulnerable to theft. Billy was most excited about Harry's expertise regarding alternative fuel technology:

"[Harry was] very influential because he was really encouraging about this technology…and he's the one that pointed out the hydrogen technology…he just opened up some questions…(that) I couldn't answer…(I'm) already thinking that electricity might already be outdated…if they're exploring other technologies."

PHEV assessment: Saving money at 50 mpg

By the end of his PHEV trial, Billy was impressed with the technology. His emphasis was on getting "more miles per gallon, from a cost savings standpoint." While Billy feels that achieving 100 MPG would be "cool," he was happy enough with around 50 MPG, which is "just ideal because I'm comparing it to what my motorcycle gets, so if I can get at least that much that would be great." For Billy:

> *"The exciting part of it is the electrical part… an ideal scenario is an electric vehicle that is as powerful and can last as long…and that is what I was trying to do [in the design games in part two of the online survey]…because electricity definitely doesn't cost as much.*

However, Billy clearly expressed reservations about what kind of plug-in vehicle he would want to own, outlining several inclinations that ultimately favored a truck design. He wants a vehicle that is stylish like a truck: as a "single guy…I'm not going to drive midtown in something that looks like an egg." He also values the practicality, versatility and safety he associates with trucks. Further, Billy expresses uncertainty as to whether PHEVs represent the future of technology, particularly after **Harry (R)** mentioned the potential for hydrogen. Billy likens vehicles to computers, describing alternative-fuel advancements as a progression of upgrades to conventional vehicles: "people are with hybrids today…[now] potentially a plug-in…and then, all of a sudden maybe that hydrogen technology will outlast what you guys are offering here."

Why did Billy Woods conclude with private interpretations?

Billy began with a primarily private-motivated lifestyle; he had not considered pro-societal values when making previous vehicle purchases, and he did not devote any significant time or resources to pro-societal practices. However, during his trial he briefly became interested in pro-societal interpretations of the PHEV before returning to this private-motivation. This process can be explained according to the three factors identified in Table 15.

Around the time of his PHEV trial, Billy demonstrates a high degree of lifestyle liminality. He is recently divorced and engages in many different recreational activities. He has a variety of friends and casual acquaintances from a variety of social groups, including coworkers, golfing buddies, and friends from bars and nightclubs. He also earns a relatively high income and is flexible about working from home or the office. Billy is not committed to a particular routine, set of activities, or social group–he is dabbling in a variety of contexts. Thus, while he initially views the PHEV from his usual private perspective, when the notion of pro-societal benefits arise he actively considers rather than discards them

Billy is also able to consider pro-societal values because he quickly comes to understand the basic functions of a PHEV. Trained as an engineer and experienced in the computer industry, Billy regularly works with new technologies and has little trouble understanding that by plugging in the PHEV, he can charge up the supplementary battery and reduce his gasoline use. Although he is unable to quantify his gasoline use, electricity use or overall fuel savings, he easily grasps such outcomes in a general sense.

However, Billy's rejection of pro-societal values occurs in a social context. Billy is disappointed to find mixed responses to the PHEV. Many of his relatives and acquaintances seem disinterested in the PHEV altogether, or are unable to grasp what it is. Of the alters that are interested, some encourage Billy to explore the PHEV's functions, while others' criticize the PHEV's performance. Interestingly, although some alters seem to exhibit pro-societal values, such as his Pat and June, Billy does not explicitly discuss such values with these people. Billy does bring up pro-societal considerations with one particularly influential group of coworkers, and when they declare a lack of support for pro-societal values, Billy concurs and drops further consideration of this alternative lifestyle. Thus while Billy's lifestyle and functional awareness support a transition to pro-societal values, the transition is ultimately blocked by an apparent lack of support in relevant social groups within his social network.

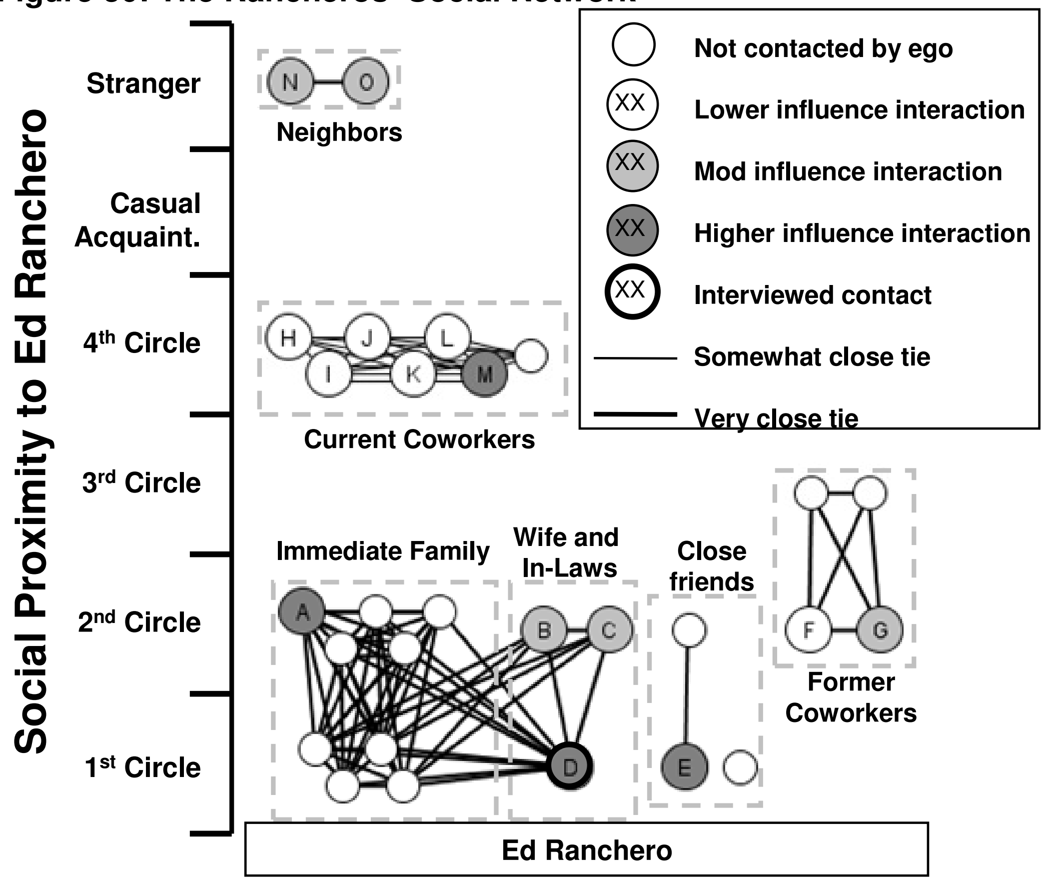
6.3.2 The Rancheros: Recharging versus family safety

The beginning: Family priorities and energy concerns

Ed and Silvia Ranchero are in their early thirties, have been married for three years, and live with their eight-month old daughter in a condo east of Sacramento. Ed was raised in Mexico, moved to the U.S. in the mid-90s, completed a degree in mechanical engineering and currently works for a small consulting firm in Sacramento. Silvia emigrated from

Puerto Rico in 2005, and now works for a software company. The Rancheros are highly focused on their child and Silvia's parents have temporarily moved in to help out while Ed and Silvia maintain their careers. They have a relatively small social network, where Ed's alters (Figure 30) consist mainly of family and former or present coworkers (Silvia was unable to complete the sociogram construction portion of the study, but describes a similar network pattern). The Rancheros earn a six-figure income, though Ed feels uncertain about the economic climate because several of his friends have recently been laid off.

Figure 30: The Rancheros' Social Network



The Rancheros own two vehicles, both of which Ed purchased new: a 2001 Ford Ranger and a 2005 Honda Accord. Ed bought the Ranger after graduating from college because he liked the "big engine" and was not then thinking about the environment or fuel economy—"gas was $1.00, $1.50, at most back then…[and] I didn't see a problem with making a good income." Ed bought the Honda Accord shortly after marrying Silvia, which he frames as part of a larger shift in lifestyle: "before I wanted to look sporty…[but now] I need a four-door to get in and out easily…to put my kid in something that's safe…reliable…my needs and wants have changed." Ed also describes how he has recently become more interested in energy use for economic reasons, as well his family's future:

> "*I want to do my part in reducing global warming…less CO_2 emissions…I want to help be part of the solution, not part of the problem…I wanted my daughter to have something…an environment that is free of pollution when she grows up…that definitely became more important when she was born…your focus totally changes from being on yourself to being on somebody else.*"

Prior to their PHEV trial, the Rancheros were already somewhat aware of electric-drive vehicles. Ed had recently driven a Prius owned by his company and judged that it is a "nice car" that helps "you save a lot of gas." He had also heard about the Chevy Volt as a "fully plug-in" vehicle. Silvia had less experience with electric-drive technology, but had ridden as a passenger in a coworker's Prius. The Rancheros did not expect the PHEV to be a Prius—they envisioned something like "one of those weird ones you see…like three wheels…like a fully electric car." Ed also assumed the PHEV would be a "slower" vehicle, while Silvia didn't know what to expect.

The trial: Fitting a PHEV into a hectic lifestyle

The Rancheros drove the PHEV frequently throughout their trail, replacing the Ford Ranger for Silvia's commute during the first four weeks then replacing the Accord for Ed's commute for the latter two weeks. Silvia was initially unnerved that the engine would turn off, but soon adjusted to the differences of driving a Prius. She typically drove alone, though she sometimes drove with her **father** as a passenger. Silvia noticed her father's "strong appreciation for the fuel economy…how that could translate into saving money" and how he overall "loves riding in the car." For Ed, the PHEV was a "pretty smooth ride." He talked to a few alters about the PHEV, including his close friend **Hunter (E)** who asked him to look under the hood, and later criticized the vehicle's acceleration—"it feels like it's dragging something." In a later conversation, Ed's **boss (J)** made a similar remark the company Prius didn't have the same "pick up power" as other vehicles.

Surprisingly, the Rancheros only plugged in their PHEV four times during their trial—less than eight hours of total recharging. They offered several explanations. At first, Ed mistakenly estimated that recharging the extra battery "didn't make any difference" relative to the regular Prius. When researchers later explained how to read the Prius monitor, Ed determined that plugging in could improve the PHEV's fuel economy by four to six mpg. Still, he felt this benefit “wasn’t really worth it for me…I was expecting like a 10, 15 [extra mpg]…but six?…I don’t know.”

The Rancheros perceived other barriers to recharging; they did not feel comfortable leaving the PHEV plugged in overnight. The first issue is the threat of fire. While Silvia knows “logically that it shouldn’t be a problem…there’s still an icky feeling in the back of my head that makes me uneasy…no, I have a baby, let’s not try this, you never know what’s gonna happen.” Ed was similarly concerned, and at one point “checked for the [electrical cord] being hot.” Due to these safety concerns, the Rancheros would park the PHEV on the street rather than in their garage, which added concern that the electrical cord might be stolen if left unattended. As a result, the Rancheros tended to forget to plug it in at all. Ed explains he would likely recharge regularly if he was single or didn’t have a daughter, “but coming home from work to take care of her…after 9:00pm you do some eating, some watching TV…and you forget about it.” At one point, Silvia’s explained their predicament to her boss, **Albert**. He teased: “well how hard is it Silvia?...you get home, park the car, plug it in…before you go, you unplug it and go.”

Despite their lack of recharging, the Rancheros were still excited about their gasoline and energy savings. Ed would regularly watch the Prius monitor to get “an idea of how much gas…efficiency you are getting out of the car”. Silvia would also watch “every now and then,” and liked to “look at the mpg…it’s encouraging.” She also logged onto the V2Green website to try to determine the effect of the PHEV battery. Although she found the data to be too confusing, she was able to get a sense of how their fuel economy compared to other drivers: "it was kind of sad…to see that everybody else was averaging like 60+ mpg…we're still sitting at 41…that's not fair…but of course we're not plugging it in…that was a reality check." The Rancheros agreed that they were saving money with the PHEV, but could not make precise estimates. Ed tried to calculate his savings based on the costs and frequency of refueling, ranging from a savings of "about $15 in a week and a half" to "about $20 to $25 every other week…that's good savings right there." He felt they averaged about 40 to 42 mpg during the first two weeks (without the extra battery), and about 46 to 48 mpg during the latter month. The Rancheros were aware that electricity costs would have to be factored in, but "didn't calculate it." Silvia added that she also appreciated "not having to stop at the gas station" so often—as she told

Box 4: Ed and Silvia
Debating environmental issues

Ed and Silvia do not typically discuss environmental issues with their friends and family, but they do often "debate" with each other. The dialogue below illustrates one such interaction that took place during an interview:

Ed: *"That's something that politicians are looking into today…clean coal technology…I don't think there is clean coal technology…I mean what is it?…they try to capture the CO_2 and convert it to liquid and put it in the ground…is it going to stay there?... I'm not really sure how they can make it clean…and you have China and India building coal plants, like 5 a month… it's really kind of disappointing."*

Silvia: *"Well, there is not a magic wand…"*

Ed: *"It's a huge issue…I don't know how we are going to get out of it…there's a lot of economics…you have to power you're economy…but at the same time…you're damaging the planet…I don't know if I'm being alarmist."*

Silvia: *"Well you just have to start looking at the glass half-full…baby steps…I think we probably could have started a long time ago…but…its just a matter of taking the steps now…try to stop the snowball effect…."*

Ed: *"I guess I don't have much patience…I want to get things done faster… changing something that's been in place for over 100 years, isn't something that is going to happen over night…it'll be another 100 years to probably change it…we need to start on stuff somewhere…I guess we're trying to do our part…by testing the Prius…it's definitely a good thing, but you gotta look at the whole picture… using a plug in… where's that energy come from…energy cannot be created, cannot be destroyed."*

one Prius-owning coworker, **Harriet**.

The Rancheros were uncertain about the environmental benefits of the PHEV. Ed explains: “we’re trying to avoid…CO_2… but at the same time as you plug it in, you’re helping somebody else pollute even more.” He had spoken with two coworkers, **Irvin (L) and Jake (M)** about how most electricity is produced by coal, recalling an episode of 60 Minutes reporting that 80 percent of CO_2 emissions are from coal fired plants—“they are the worst polluters…we’re kind of chasing our tail, aren’t we?” However, Silvia was not as pessimistic about the future of electricity emissions, and she and Ed would often debate their differing perspectives. [See Box 4.]

Silvia talked to a total of six alters about the PHEV, but did not consider these

Silvia: *“So what you’re saying is…because there is still a part of the energy that helps the car run, that is coming from electrical…which comes from the power plant…it’s like the same thing as just running on gas?”*

Ed: *“Well, it’s even worse…I don’t know how efficient these power plants are, but to me they’re very inefficient… when you burn coal, I’m sure you heat water…you turn it into vapor and it turns your turbines…when you burn the coal, it emits a lot of CO_2, which is a greenhouse gas…which you are trying to avoid…if you have a solar plant…a wind turbine…. you’re not causing any…gases…but if you’re looking at how the energy is produced in the U.S…you’re burning petroleum, oil, coal…a little fraction of that energy is coming from wind and solar.”*

Silvia: *“If cars started moving in the direction of being able to run like they’re setting up the Prius now… eventually the market is going to have to switch a little bit and get a little smarter with ways they are going to provide the energy, right?*

Ed: *“It’s all about money…if you have to replace all plants with new technology, it will cost money…”*

Silvia: *“…and [replace] old mindsets with new mindsets [laughs]”*

Ed: *“I feel frustrated because [we] can really do nothing.”*

Ed is frustrated about the state of existing infrastructure, such as coal-fired plants, while Silvia is more open minded about the future. She sees that change can be incremental, and she is less worried about the specific limitations of the present. Despite these differences, Silvia notes that they both have become more concerned about the environment since the birth of their daughter:

> *“I know we both think about it more so now that we have a baby…she’s going to grow up and… she’s not going to be able to see outside and enjoy the weather because it’s going to be so polluted.”*

interactions to be very influential—"I don't take into consideration what my coworkers have to say." She found that coworkers were not interested in the PHEV, even though many are "really in to cars" (except for **Harriet**, who would tease that the PHEV trial would "convert" Silvia to a Prius lover). In one instance when **coworkers** were talking about cars, Silvia explained her trial. One coworker replied, "no, that car is in a different league…so let's not even bring it into these conversations." Silvia explains that "in their heads, the Prius is just something else…there's not the excitement [or] anything that really pushes them…it's not a sports car…are you going to go racing with a Prius?" Ed similarly observes how an HEV or PHEV is not viewed as a typical vehicle among their alters:

> *"when you are talking about a sports car…the Prius moves slower…you're not really impressing anybody…people use their cars to impress people…to show their social status…how good financially they are doing…if you show up with a Corvette, people are like, oh, wow, he's doing really good…he's really making money…if he shows up with a Prius, people are like, oh, he's doing okay…but he's just probably more environmentally concerned…they can't really compare."*

Ed also discovered that most friends and coworkers were not very interested in the PHEV or their trial. One "hard core republican" **coworker (H)** only asked if the project was funded by "Obama dollars," and Ed's **brother (A)** and **friend (G)** only casually offered criticism about Toyota. Ed noted that only a few people thought PHEV technology "is cool." One **coworker (M)**, brought a magazine article about Tesla to work, and asked Ed a few basic questions about the PHEV trial. Ed was also intrigued when from a distance he observed two **neighbors (N and O)** looking at the PHEV plugged in outside their condo, and asking each other if the car was electric. Ed felt it was "kind of cool…[to] show them that there's a new technology coming out."

PHEV assessment: Fuel economy, family-sized, then environment

Although Ed and Silvia had initially talked at length about their environmental concerns, by the end of their trial they primarily highlighted economic (fuel savings) and family (space) concerns as higher priorities. Despite their demonstrated inability to regularly plug in their PHEV, they maintained a willingness to pay for plug-in capabilities, or at least an HEV with high fuel economy. Ed feels it is "reasonable to pay extra for more fuel efficiency," such as an incremental cost of $4000. He anticipates that if he were to seriously consider an electric-drive vehicle, he would perform a payback analysis—"if it takes 10 years to pay off itself…it's really not a good option." He notes the uncertainty of gas prices complicates such an estimate, where an increase "to $4.50 per gallon" would make the PHEV even more desirable. Not surprisingly, the Rancheros wants a PHEV with short recharge time, and Ed is particularly excited about all-electric capability, "at least for 10 to 20 miles." In any case, they want their next vehicle purchase to be a midsize SUV, like a Honda Pilot, to accommodate their plans for a growing family. Regarding environmental concerns, the Rancheros explain that "if you have the chance to help the environment with the same amount of money, then yeah [we'll do it]."

Why did the Rancheros conclude with private interpretations?

One factor that contributes to the Rancheros initial consideration of pro-societal values is their functional understanding. As generally technology-savvy individuals—Ed is an engineer and Silvia works in software—the Rancheros are quick to learn about the PHEV's operation and functional benefits. They are comfortable with the idea of substituting electricity for gasoline, and consider notions of increased fuel economy and payback analysis. With this background knowledge, the Rancheros are able to consider larger pro-societal controversies, such as considering the environmental impacts of electricity generation.

Further, the Rancheros lifestyle is liminal in a transitional sense. Their recent marriage and new child are shifting their priorities—as exemplified by Ed's transition in values from his power-motivated pickup truck purchase to his family-oriented sedan purchase. They also became more interested in environmental issues in relation to their child's future. However, some of these new priorities and lifestyle changes conflict with one another. The Rancheros lifestyle is becoming less liminal as their family patterns become routine and centralized around their young daughter. Focusing on their daughter's safety and care, the Rancheros are too cautious and resource-constrained (in time and effort) to integrate regular PHEV recharging into their daily schedule. They hold the immediate needs and safety of their daughter as more important than indirectly benefitting her through long-term environmental benefits or cost savings. Thus, while their lifestyle shift has brought new awareness to pro-societal issues, their increased commitment to family acts to sustain the private values of the household.

Also, both Ed and Silvia were surprised and "sort of disappointed" with how little interest their PHEV trial generated among their alters. They expected "more people to be more open minded" or "hyped." about the PHEV. However, most alters demonstrated only casual interest in the PHEV, or none at all. The Rancheros explain that HEVs and PHEVs stand outside of the realm of typical vehicle discussion within their groups, and most alters were not openly committed to pro-societal values or lifestyle practices. Ed imagines that "if people were [more] excited about it…the [PHEV trial] would have been a little bit different." Thus, while the Rancheros' functional understanding and lifestyle transition could have supported a shift to pro-societal values, the clash with growing family-oriented values and lack of pro-societal network support quashed any serious commitment to these interests.

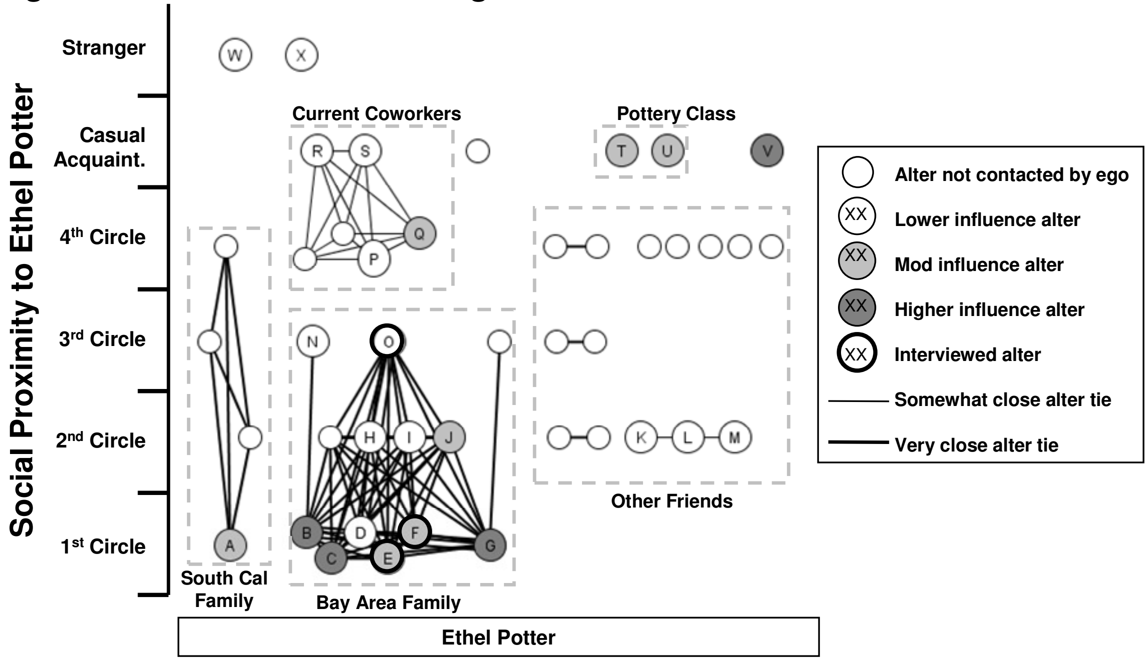
6.3.3 Ethel Potter: Embracing societal interests

The beginning: Wanting a more "ecological friendly" car

Ethel Potter is in her late fifties, and lives with her husband and college-aged daughter, **Christy (F)**—the youngest of her eight children and last one living at home. Their newly bought home is cleanly kept, with a neat garden out front and spotless wooden floors inside. Ethel was recently laid off and started a new job for a loan auditor about 15 miles from home. During her PHEV trial her workplace moved to a new location only two miles from home, prompting her to think about cycling to work. She currently uses her 2005 Dodge Neon for commuting and running errands. Ethel describes her Neon as an “impulse buy” that she bought one day because it had “good pick up…good mileage” and was overall “cute.” She enjoys others’ reaction to her “sporty” car: “some people may be surprised that that’s my car…that I’m not driving the big old station wagon…the old Grandma car.” For the sake of household budgeting Ethel would often track her gasoline use in the Neon (recording fuel expenditures in an budgeting program), and knew she averaged around 28-29 mpg.

Ethel was generally interested in “ecologically friendly” technology, such as the Smart car, which she contrasts with “pig cars” like the Hummer—“there is absolutely no reason for anybody to drive a Hummer…I want to get out and kick them.” She had no prior experience with electric-drive, and anticipated the PHEV would have “slower pick up” that is “better for gas mileage.” She would buy such a car if “it made sense ecologically,” though after talking to a coworker, **Rose (Q)**, she was concerned about the toxicity of batteries and the impacts of electricity generation. Ethel had also previously thought about purchasing solar panels, partly because she was concerned about the energy required to cool her large “pig house.” She expected that her PHEV trial would generate interest among her alters, which largely consists of family and coworkers (Figure 31), potentially regarding energy and environmental issues. Ethel has always been interested in science and discovery, and had tried to inspire such interest in her children when she home-schooled them—hoping that some would grow up to become scientists.

Figure 31: Ethel Potter's Sociogram



The trial: A quick convert

After her first test drive of the PHEV, Ethel "was a convert…amazed at how well it ran…I was very impressed." She was initially overwhelmed by the interior, where "everything is digital and electronic now." She liked that the engine would turn off when stopped, though her **husband (G)** thought this was "spooky." She noted that the PHEV "responded really well" when she needed to accelerate, though there would

Box 5: Christy's perspective
PHEVs to save oil, air, and money

Christy is one of Ethel's daughters. She is in her twenties, and lives with her parents in the Sacramento area. She recently finished a university degree in interior design, and currently works at a hardware store. She drives a 1997 Mercury Tracer handed down from her father. Prior to her mother's PHEV trial, Christy had never been in an HEV before—she had only seen Priuses on the road.

Over the course of Ethel's PHEV trial, Christy talked to her about the PHEV on several occasions. Ethel had excitedly mentioned the PHEV trial at their family vacation in Lake Tahoe. Later, Ethel would tell Christy "how much she liked it," and Christy asked about "certain safety features…like what if you leave it plugged in and then you start driving off." In the second or third week, Ethel took Christy for a test ride around the neighborhood to show her "all the bells and whistles" like the "dashboard LCD screen…where it's drawing its energy from…battery versus gasoline…that was really cool." During the drive, Ethel was sometimes be a "very slight hesitation." Throughout her trial, Ethel completely substituted the PHEV for her Neon. She did not try cycling the two miles to her new workplace, and explained that she might not feel the need to if she owned a PHEV—"with that car, it's just like…no biggie…I would probably not feel as pressured to ride my bike." Ethel was also initially excited to tell alters about the PHEV: she took advantage of a family vacation to explain the trial to her children and other relatives, and tried to recruit them as secondary participants.

Ethel recharged her PHEV almost every night—what she called an easy "habit." She soon got used to the Prius monitor and learned to identify if she was driving with the engine off. She also viewed some of the information provided by V2Green website, feeling proud about her fuel mileage over certain trips and how she was "barely beating the average" of the

trying to drive it "as economically as possible…completely on the battery the whole time." Christy was also present for other conversations where Ethel would explain the car and study to other friends and family members that were visiting. Like her mother, Christy was surprised that other people didn't seem very interested: "I know the technology is not out there…the plug in part…and I thought people would notice that and question her about it."

Overall, Christy notes that Ethel was really "jazzed" about the PHEV: "she's always interested in cool things like that…things we've never seen before." Christy compared this excitement to Ethel's enthusiasm about her current pottery class—"different hobbies…it always seems like there's something." Overall, Christy feels that her mother was "somewhat influential" over her own perceptions of the technology. Ethel only briefly talked about the car itself, and "didn't really elaborate on the environmental reasons for it…we didn't get into too much depth."

Christy associates three main issues with the PHEV: oil independence, air pollution, and economics. She used to try to ride her bike and take light rail to school and work sometimes in environmental efforts. However, her vehicle ownership has been primarily driven by "whatever was cheapest…I need a car now." She wishes she "had the luxury of choosing what car I had." Christy does talk about environmental issues with her friends "pretty often," such as talking to her boyfriend about solar energy.

Depending on her job situation, Christy thinks she will buy a new vehicle within the next 5 years, potentially a Subaru because she likes "going outdoors…all-wheel drive…we go camping a lot." She would be interested in a PHEV Subaru if it was available and affordable, though she was not particularly interested in all-electric capability or a CD range longer than 10 miles. Christy thinks a PHEV would be most successful with people that have "disposable income" and are "concerned about the environment."

other PHEV drivers. Using this website, Ethel accurately estimated that she averaged around 55 mpg in the PHEV, though some trips were "over 70…that was pretty good." She also did not have to refuel the vehicle as much as her Neon, and was pleased that at times she would forget the vehicle used gasoline at all. While Ethel thinks she saved money during her trial, she couldn't precisely estimate her savings. She guessed she spent about $30 less in gasoline but had "no idea about the electricity." She feels that cost savings are not her biggest motivator—she is more interested in reducing "dependence on oil."

Ethel discovered that some alters were particularly supportive of the PHEV—she considered social interactions to be most influential when people displayed "interest, enthusiasm and encouragement." Examples included her

Box 6: Jane's perspective
PHEVs as environmental, but personal needs matter

Jane is another of Ethel's daughter, is in her twenties, and lives in the San Francisco Bay area. She works at a mortgage bank and owns a used 2002 Hyundai Santa Fe that she bought for its decent fuel economy and spaciousness that facilitates outdoor activities. She first heard about the PHEV during Ethel's initial group survey invitation during their family vacation. Jane did not see the PHEV until the end of Ethel's trial—it "looked like just a normal car…small, compact." Ethel said "she liked driving" the car. Jane explains that they were already talking about politics and environmental issues at the time:

> *"we were talking about…ways to…go green…how people could get involved…our own personal things…what we were doing…I think that's why the car came up…the different things right now that we were concerned about…like the economy…healthcare…I think that's why she said, oh yeah, I'm driving that car…then we were talking about…if that would help lower greenhouse gases and that sort of thing… we were talking in general terms."*

Jane and Ethel often talk about environmental issues, including discussions about their vehicle's gas mileage, and "oil and oil companies…how if they didn't have to deal overseas with anyone…that our country would be better off in so many different ways."

Jane likes the idea of the PHEVs because it could "reduce the use of gasoline…I think that would be a huge benefit to everybody." She feels that "the fact that we get our oil from the Middle East I think causes a lot of safety concerns for our country…people's lives." She is also concerned about global warming, and thinks that PHEVs might reduce greenhouse gases, though she is not sure by how much. Jane is excited that "there are finally options… we have so much technology in other areas… and it just seems that cars are the one thing that have not really changed at all." She feels she has become more aware of environmental issues, largely through "Al Gore and the whole global warming thing." Mary thinks that people daughter, **Dana (B)**, whose opinion Ethel respects because she "obviously thinks about things a lot…it's not just off the cuff…she's not afraid to let you know how she feels." Dana did not see the PHEV much during Ethel's trial, but at the end commented that she was interested in getting an "ecological car" and thought it was funny that HEV drivers are often incorrectly perceived as being "weirdoes… Birkenstock wearing tree-huggers." Another daughter, **Kristen (C)**, was also encouraging, saying that the PHEV "was really cool." Ethel explains that Kristen would often encourage her to "do something new…not to let someone make fun of me for doing it." Ethel also talked to **Greta (U)**, a woman in her pottery class that was interested in the PHEV, and their discussions touched on solar energy, home insulation, and generally being "more ecological and

that are more educated and "conscious about the environment…really knowledgeable about what's going on in the world" would be "more inclined" to buy a PHEV. For instance, she thinks her sister, Dana, would be interested.

For her next vehicle purchase, Jane thinks she would probably research different types of vehicles "now that I know more about…hybrid cars, that kind of thing," though she would still "make a decision…based on my personal needs." Jane might be willing to buy a PHEV. She describes that she "usually only drive[s] about ten miles a day," and though she doesn't have a recharge outlet at home, she thinks she could find one at work. Overall, Jane feels that her mother was not influential over her perceptions of PHEVs because they didn't talk much about the vehicle's specific features. However, she explains that Ethel "is a very smart lady," and in knowing that "she loves it…I would be more inclined to love it also."

Box 7: Tom's perspective
PHEVs as a good way to save money, environment

Tom is married to Ethel's oldest daughter, Kara, and they live with their two young children in the San Francisco Bay Area. He is in his thirties, works in construction, and owns a 1997 Volvo 850 and a 2001 Honda CR-V. Tom was familiar with HEVs prior to Ethel's trial, such as being driven as a passenger in his friends' Priuses. He thinks the Prius is "a good vehicle" that might be good for the family and he has heard "nothing negative" about it, though he is "leaning towards a truck" for his next purchase to help with his hauling duties at work. Tom also notes that his Prius-owning friends typically drive enough to make the economics of fuel savings worthwhile.

Ethel first contacted Tom when she emailed him an invitation to the PHEV survey. Tom only talked with her in person when she visited their home after her trial ended. Tom asked about the car and Ethel explained that she "thought it was a good idea" and enjoyed getting "great gas mileage…50 to 60 mpg"—

economical." Ethel liked that Greta was into the idea of "quality of life…rather than trying to drive the biggest car…or have the biggest house…she just seems more down to earth."

which Tom thought was great compared to his 20 mpg car. Tom's only concern was the cost of the PHEV conversion, which would be "like $10,000." Tom was not sure what Ethel's motivation was in liking the PHEV, but figured it might be "money…or being self sufficient…or using less oil."

Tom's motivation to purchase a PHEV would be to "save money" as well as reduce oil consumption. He doesn't know how much money such a vehicle would have to save to be worthwhile, but he notes: "if I was going to buy one…I would…calculate that…I'm sure I could probably figure that out." He also thinks that "it's a good idea to be more self sufficient as a country…using our own oil," as well as reducing "pollution and emissions." His household tries "to recycle as much as possible," and "conserve electricity" by turning out unnecessary lights. Tom explains that owning a Prius or PHEV could send multiple messages: "someone could think…they're some hippy or something, trying to save the earth…that may be one interpretation…or they're trying to save some money…or they're trying to lessen the foreign oil that we buy." Tom was "intrigued" by Ethel's experience, which helped him to gain "more knowledge about the whole technology…learning about the options and the technology…what's possible…that was cool." He identified a Hyundai Veracruz as his likely next vehicle purchase, and he would be willing to spend $4-5k extra to upgrade to a basic PHEV version, though he didn't "crunch the numbers and figure it out."

Ethel's PHEV trial also helped her to contrast her current values with those she use to have, as well as those of people around her. At one point she reflected on her **boss's (P)** sports car:

> *"for the first time I saw her car today…and it's one of those little [sports cars]…way back when I would have liked to drive a sports car, but…I was looking at that car thinking, do I feel jealous?...she's got such a neat car…no, at this time in my life, I'd rather be making an impact in some way, a positive impact rather than driving some gas guzzling [car]…I just want a car that makes sense…doing something that somebody can look back and say oh, that was a good experience for that person, so maybe I'll try it."*

Ethel was disappointed that most alters showed only “casual interest,” such as her **husband’s (A)** questions about mpg, or her brief conversations with other daughters**, Christy (F)**, **Jane (E), Wendy (J) and Kara (I),** and Kara’s husband, **Tom (O)** [see Christy’s perspective in Box 5, Jane’s perspective in Box 6, and Tom’s perspective in Box 7]. Ethel was surprised that people “aren’t more enthusiastic” about the PHEV technology. She was disappointed that after initially telling most of her family about her trial, when she brought it up later, “half of them said they never heard anything about it…nothing sticks.” Most coworkers and several friends also seemed too busy to take much notice of the PHEV.

PHEV assessment: Towards a solar car

Though Ethel had initially “expected not to like” the PHEV (thinking that it would be a slow, small car), by the end of her trial she was pleased with the vehicle’s acceleration capabilities, quietness and efficiency. She was particularly motivated by the PHEV’s ability to lessen oil dependence and reduce emissions. She explains that “we’re just such pigs with energy…gobbling up energy…it doesn’t seem right.” Although initially concerned about battery toxicity, Ethel did not address the issue in her final assessment. She maintained caution about the impacts of electricity generation, and became particularly excited about the possibilities of solar energy. In fact, during her PHEV trial she made a final decision to purchase solar panels—something she had been considering for years. She explains:

> *"I think I was more excited about the panels because I was test driving the car… the idea that this really could work…to be driving almost a solar car, basically…it was funny how they kind of worked at the same time…because I work so close to home, and most of my trips are just really close…if I was really careful I could just drive off the batteries."*

Ethel would like the PHEV battery to last "longer than 20 miles" so she could make it to her pottery class and back "with the battery still being alive." She hoped to pass her Neon down to her daughter and buy a Prius for herself. However, she became concerned when researchers told her the PHEV conversion currently costs over $10k, replying: "well no wonder nobody does it." Despite this surprise, Ethel maintained an interest in purchasing an HEV or PHEV, explaining that at this stage in their lives, she and her husband have more financial stability to consider such things:

> *"even ten years ago…a thousand dollars more…forget it…[now] I have the luxury…if you really want to be environmentally conscious…getting solar panels…that's an initial investment…it's going to pay for itself over time, but that initial investment isn't something that everyone can do…and I feel really lucky that we can do it."*

Why did Ethel conclude with pro-societal interpretations?

Ethel’s lifestyle has become increasingly liminal as her children grow up and move out, and as her household income and financial stability improve. For much of her life she has been interested in new scientific breakthroughs and technologies, and lately she has become more concerned about energy issues such as oil dependence and emissions. Ethel feels she now has the “luxury” to more actively consider and try out such alternate lifestyle practices, such as adopting and using solar panels and electric-drive vehicles.

Prior to her PHEV trial, Ethel’s interest in pro-societal issues had prompted her to consider such technologies and talk to others about their effectiveness. She had heard about the waiting lists for HEVs, and one coworker had warned her about battery toxicity and electricity generation impacts for electric-drive vehicles. With this background, Ethel was quick to understand the basic functions of the PHEV and appreciate the vehicle’s energy efficiency and fuel economy, as well as considering its broader societal impacts.

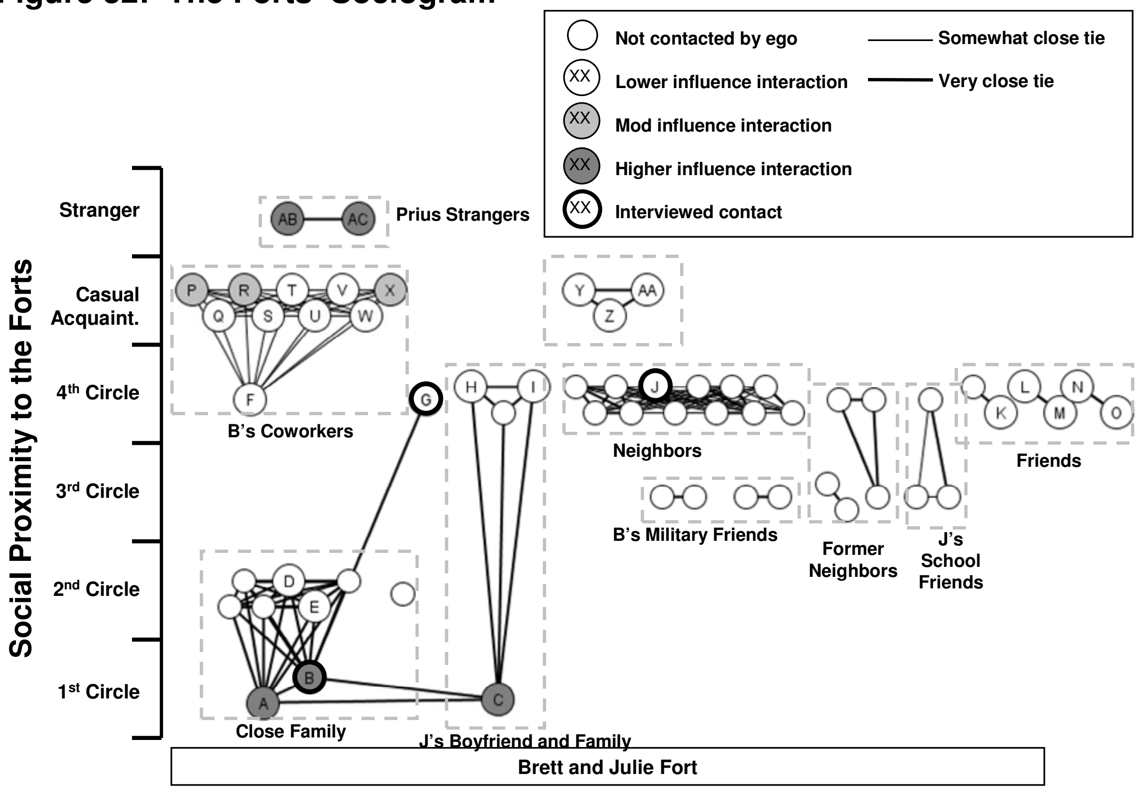
Ethel is disappointed by the lack of support from her social network—“it’s amazing how little people notice it…especially the fact that it’s a plug in.” However, she observes enthusiasm and encouragement from several key alters, such as two of her favorite daughters, a repairman that visits her home, and a new pottery class friend. In the latter case, Ethel likes how the PHEV serves as a “way to talk to her more…we’re getting to know each other…we have a lot in common.” By trying out the PHEV, Ethel found herself better able to articulate her own values and contrast them with the private interests that motivate the purchase of sports cars. Such support and reflection help Ethel to solidify her initial interests in pro-societal values, empowering her to take additional action such as deciding to purchase solar panels and planning how to purchase a Prius, or potentially a PHEV.

6.3.4 The Forts: Hummer to hybrid

The beginning: Mass always wins

Brett Fort is in his forties, and lives with his wife, **Selena (B)**, their college-aged daughter, Julie, and their teenage son, Rex. Only Brett and Julie too part as primary participants in the PHEV trial [see Selena's perspective in Box 8]. Brett works as a computer engineer about 30 miles from home, while Julie attends University about 15 miles away. The Forts own four vehicles—three of which are very large. Years ago, Selena had "been hit twice in small cars by full size trucks," and the Forts now believe that "mass always wins" from a safety perspective. Julie drives a 2006 Dodge Ram that her parents bought for her because it was "something big." Selena drives a 2002 Chevy Suburban for running errands and shuttling her son to school, and eventually hopes to replace this with a Hummer H2 (after falling in love this model at an H2 demonstration). They also own a 2004 Chevy Silverado to haul their camper, dirt bikes, and ATV for weekend camping trips. Brett owns their smallest vehicle, a 1994 Honda Accord he bought used as a cheap commuter vehicle because the Silverado proved too expensive on gas (he had used a spreadsheet to determine the Accord's potential savings). The Forts did not consult alters beyond their immediate family when making any of these vehicle purchases. The social network of Brett and Julie is depicted in Figure 32.

Figure 32: The Forts' Sociogram



Prior to their PHEV trial, Brett was fairly familiar with electric-drive technology. At his workplace there are "tons of people that drive [HEVs]…everyone that has one loves it," and at least one EV owner. His main concern is that the "calculations aren't there yet" for an HEV to save money, but he adds,"from an environmental standpoint, it makes a little more sense." Julie is more attracted to the environmental benefits of HEVs, describing how she feels social pressures from the "dirty looks" Prius owners give her large pickup truck. The Forts explain that as a household they have become more interested in environmental issues in the last few years, largely driven by Selena's leadership: "we use environmentally friendly dish washing soap and laundry soap…turn the shower off halfway…we recycle everything…[Selena's] become very green over they years." [See Selena's perspective in Box 8.] For example, they have become more rigorous about recycling, reducing energy use and conserving water. However, echoing her mother's safety concerns, Julie is hesitant to drive a smaller vehicle: "if everyone drove a Prius, I'd be good driving one, but…you know, I drive big cars because people drive [big cars]…in a little car, it's scary."

Box 8: Selena's perspective
PHEVs for the environment…but Hummers for fun

Selena is the mother of the Fort household. Selena was very interested in the PHEV and she frequently rode as a passenger in the vehicle and discussed it with Brett and Julie. Selena was surprised by the comfort and legroom of the Prius, and asked Brett a barrage of questions about "driveability," performance, recharging at work, and the monitor. She asked if he felt "inadequate driving it" and if he would consider buying one. Selena also discussed the vehicle with Julie, though they did not talk in as much depth. Selena was particularly surprised by the Prius' size, which shifted her perceptions of smaller cars: "I'm not fond of being in little cars…but I didn't have a fear in the Prius of it being little… I asked [Brett] if he felt safe in it and he said yeah." Selena would comment to Brett on how "this is really cool, saving money…on gas," and she liked discovering new features of the Prius interior every time that she got in.

Selena's primary interest in the PHEV that it is "better for the environment," and that she thinks "it saves money"—though she admits she hasn't received her electric bill yet. She also likes that the PHEV delivers these benefits without making her feel "gypped in the way…of comfort…or feeling safe…or amenities." The environment has become more important to Selena in recent years. Selena explains the trigger: "I started watching Oprah more in the last couple of years…she just brings up a lot of good topics…so I've become more aware…and done more research." Selena has put this concern into action in her household by replacing plastic drinking bottles with stainless steel, increasing recycling, running their dishwasher and laundry machine off peak, using compact fluorescents light bulbs, and buying energy efficient appliances. She wants to instill these values into "the kids," telling her son: "I'm trying to save the earth for you and your children someday too…so if we all do our share…every bit helps."

Selena sees the PHEV as another way to help the environment. She notes that her father was skeptical about environmental "malarkey," that "to get the electricity you have to burn oil."

The trial: Big surprise in a small car

Brett fully replaced his Honda with the PHEV throughout their trial and driving it to work, as well as using it for a few family trips (which they normally didn't do with the Honda). Julie drove the PHEV on a few occasions. The Forts spent some time learning about the Prius as a family, such as when **Selena (B)** helped Brett experiment with the rearview camera to get a sense of depth perception. Selena had been very interested in the PHEV since their trial began; she had numerous discussions with Brett and Julie, and was a frequent passenger in the Prius. Throughout their trial, she would ask Brett and Julie about their perceptions of fuel mileage, comfort, and performance. As Selena became more impressed, she began "trying to talk [Brett] into getting one."

> However, Selena thinks that electricity can be made using different sources—"there's hydro…there's wind…there's so many different ways." In all, she feels that the "cleanliness of running" the PHEV is "positive for the environment."
>
> Another initial concern for Selena was the "stigma" she associates with electric-drive vehicles, which she explains will differ in different communities. In most communities, where "bigger is better," she feels that a Prius is seen as "a weenie thing…it [is] looked down on and made fun of." On the other hand, she notices that Davis, where both children attend school, is different, where "some of the people [look] at us differently" for driving a larger vehicle. In sorting through these different values, an influential experience for Selena was when the Prius owners waved to her family on the highway: "we were like, oh there are other people that think this is a good thing…I saw more people looking at it as a positive than I [expected]."
>
> Selena could imagine buying a Prius or PHEV for their household. A Prius-like vehicle would be particularly well-suited to replace Brett's car as a commute vehicle. She would want a larger vehicle if she were to replace her Suburban though. She notes the irony that her next dream vehicle is actually an H2 Hummer—"I really think they're cool…and I've driven them, and they're awesome, off road." She feels this desire is "really bad for a lot of different reasons," but even with her newfound excitement for the Prius, part of her still wants the Hummer.
>
> Overall, the Forts' PHEV trial had a large influence over Selena's perceptions of the technology. She explains that her "opinion had definitely changed" in a positive direction. Her previous perceptions were base on "hearsay," but now she feels she has a firm understanding of the technology and its benefits.

Brett liked the vehicle's handling, though "it's kind of lacking power" relative to their other vehicles. He expected this: "I know it was a hybrid, and it's built for gas mileage…I knew the energy wasn't going to be big." Julie liked the console: "it's really technologically up there…how it's all digital." The Forts were particularly surprised and impressed with the spaciousness of the Prius, such as one family trip where all four of them comfortably fit in, including camping chairs and picnic supplies. However, from a safety standpoint, Julie feels more comfortable in her truck, particularly on the freeway—the car is "just really small" and she doesn't like being "at butt level."

For the Forts, recharging at home was "not a problem"—Brett would plug in when he got home for work, then unplug when he fed the dog in the morning. Brett was only able to plug in at work a couple of times; although there are several EV parking spots, they are normally taken by "golf carts" used by employees to traverse the campus.

Brett would look at the Prius monitor and V2Green website to view his fuel

Box 9: Guy's perspective
PHEVs as self sufficiency

Guy is in his thirties, and lives with his wife and young child in a detached house across the street from the Forts. He has known the Forts since they and several other households moved into the neighborhood seven years ago—this group holds potlucks on a monthly basis. Guy considers himself to be "very close" to the Forts; he sees them in the street "nearly every other day." He owns a 2002 VW Beetle and a 2006 H3 Hummer. Guy mostly drives the Beetle, though the car irritates him because "that darn thing falls apart like crazy." His wife mainly drives the H3, which they bought after discovering it cost about the same as a mini-van and "it looked better." Guy boasts that they actually use the H3 for "four wheeling"—when they first bought it he "drove it into about three feet of mud…so all the neighbors [first] saw it when it was completely dirty." He notes that although people "give Hummer a bad name because of the big Hummers," he thinks the H3's are "pretty small" and "actually have good gas mileage."

Guy was well aware of electric-drive technology prior to the Forts' PHEV trial. He has a background in electronic and mechanical work, and works on his own vehicles. When the Prius was first available, he rented one for three days to drive it around and take it apart with his brother-in-law—just "to see how it worked." Guy almost bought a Prius, but his wife didn't like the design of it. Guy has also been researching the Chevy Volt, which he thinks is the ideal car for him "because it doesn't leave you stranded when you run out of power." He also considers converting his wife's Beetle into an EV. To further research electric-drive technologies, Guy is a member of EV and alternative fuel groups on Meetup.com. Guy is also interested in other environmental technologies. He has an array of solar panels that almost covers all his home electricity use—"until we put in a spa."

For Guy, environmental technologies are a way of "being self sufficient…if I can make my own power, I'm going to do it…and money savings." He is skeptical about environmental benefits in the short term, because with solar mileage and sometimes experimented to see if he could "stay on just [the] battery." He also tried to determine how long the vehicle took to fully recharge, but found the V2Green graphs were too low resolution. Julie liked to watch the Prius battery regenerate, and enjoyed the novelty of the V2Green maps, such as watching her father's location as he drove. During their PHEV trial, Brett became more knowledgeable about their fuel economy, from an initial overestimate of 50 mpg, to a more accurate estimate of "mid to low forties." He was pleased with this range, as it beat their other vehicles.

In addition to learning about the PHEV's functions and performance, the Fort's also gained new perspective on pro-societal values. In one instance, as the Forts drove the PHEV along the

panels "people don't take into account the production of the cells…and all the pollution that's created…it's debatable." He notes that while a lot of people are concerned about global warming, there is little point in worrying due to the imminent emergence of China and India as big contributors—"I don't think [driving hybrids in the U.S., etc. is] going to help…reverse anything." Guy links the idea of a PHEV to self-sufficiency, money savings, and, to a lesser extent the environment. He likes the idea of making "short trips down to the grocery store and back…on pure battery…for someone like myself…with solar…that's ideal…because my electricity is eventually going to be free…[it] would be the perfect set up for me." He also doesn't "want to be paying U.S. dollars to foreign countries that are hostile to us."

During the Forts' PHEV trial, Guy chatted with Julie in person: "I probably know more about the hybrids than they did…so they couldn't really tell me anything I didn't know already." He describes that the Forts were more interested in "fit and feel of the car than how it actually works." He got the impression that Selena and Julie "really like it," and that it "felt like a normal car." He thought that Julie might have particularly liked it because "she's probably used to driving her big truck…I'm sure it felt nice driving the car." He wishes he had had asked them about "fuel mileage" and "when it kicked over to gas or not…or if it even had to."

Guy feels that interactions with the Forts were "somewhat influential" over his assessment of the PHEV. He feels a sense of hope because the Forts "have nothing but gas guzzlers," and to see them enjoy the PHEV give him "a more positive outlook…that people of all types could drive it…because if they like the car, I think anyone could." Guy hopes to buy a PHEV or Volt-like vehicle, as long as the price is right—"the price range would have to be the high 20s to low 30s." He particularly likes the idea of having 50 miles of all-electric range, but he would be okay with less range, or mostly blended operation—"if you're getting around 50 mpg in town…that's really good."

highway, **a Prius driver and passenger (AB, AC)** waved at them. The Forts were baffled, trying to understand the event's significance:

Brett: "the wave on the freeway… that was actually pretty cool"

Julie: "we don't get waved at…frequently by strangers"

Brett: "you know, you're driving a truck…someone in a Prius doesn't normally wave at you…they may flip something at you…but it won't be a wave…"

Julie: "yeah, we felt kind of like posers…driving around…this really isn't ours…you'd hate us if you really knew what we drove…you'd be giving us another symbol."

Julie: "[like] we would be part of the family if we had [a Prius]."

Brett: "I think [this type of

Box 10: Lindsey's perspective
PHEVs to cut costs

Lindsey is a single parent in her forties, living in a detached home in West Sacramento with her two children—one in college and one in high school. She works in the administrative office of a construction company in Davis. She considers herself to be "very close" to the Forts, having known them for several years since meeting Selena when serving on their children's school boards. Their families occasionally camp and engage in off-road recreation together. Lindsey drives a 2001 Dodge Durango, which she bought because it was the right size hauling around her children who were "into multiple sports." She had not considered fuel mileage at the time because "gas wasn't really expensive then." She had not considered an HEV at the time because she was unaware of them. She has learned more about HEVs over the last few years, though before taking part in the study she thought that HEVs "were all electric…I didn't know that they were electric and gas." She had also heard of the Chevy Volt, but didn't know much about it—"just thought that it looked like it was kind of cool and it was a hybrid car."

During the Forts' PHEV trial, Lindsey talked with Selena about the PHEV on a few occasions. Selena had briefly explained the study over the phone, and said she was considering buying an HEV or PHEV. In another call, Selena mentioned that she was surprised at "how much gas you could save," and noted the mpg they could achieve—though Lindsey couldn't remember the exact numbers ("it went 100 miles or something on a gallon of gas"). Selena also explained that it was fairly easy for the Forts to plug in the PHEV at home. Lindsey was not entirely sure what motivated Selena's interest in the PHEV, and guessed that she was concerned about saving money ("she's got a household to support") as well as generally curious about the technology.

For Lindsey, the big idea of a PHEV is "saving some gas…and having the option…of using electricity or gas." She explains that she is "a single parent…you can think that there's other things that you'd rather spend money on…than putting gas in your car…the only thing that I *experience] makes you feel good about doing something good…one of those feel good moments."*

> would be concerned about…is how much it would affect my electricity bill." Lindsey didn't feel her interactions with Selena were very influential because, although she found Selena's details interesting and she respects her opinion, Lindsey's consideration of a PHEV is "going to be all about cost." Lindsey participated in the PHEV survey because she wanted to find out more about hybrids.
>
> Lindsey would consider spending an extra $3k to upgrade her next vehicle to a PHEV. She did not put a high priority on environmental concerns, though she mentions that most people that drive a hybrid would be "environmentally conscious." Lindsey explains that she does consider environmental issues ("I recycle all kinds of stuff"), but that a buyer wouldn't "have to be an extremist to buy that kind of car"—where extremists are the type of people that, for example, "make their own gas…out of vegetable oil."

By driving the Prius, the Forts felt a change in perspective. Brett explained that "it's funny because I think my opinions of the Prius…have changed since driving it." In contrast to the "dirty looks" Julie would get for her driving her Dodge Ram, Brett found himself "looking at trucks, saying, wow he's taking a lot of gas." Other social interactions involved coworkers, neighbor, and other friends and relatives—but most conversations typically did not progress beyond a brief summary of the study. Julie adds that some social experiences where nice to "hear other people's view on [the PHEV] and it kind of helps to form your own opinion." Several of Brett's coworkers were "curious" about his PHEV trial, such as a technology enthusiast, **Charles (S)**, and a hybrid owner, **Mark (R)**. Brett also talked to **Dale (X)** about how batteries have a larger "carbon footprint" than people think because of the manufacturing process, and "people are lulled falsely into this environmental [idea]…[that] these hybrids are zero emissions, zero impact…which isn't true." Julie also briefly talked to their neighbor **Guy (J)** [see Guy's perspective in Box 9] and Selena talked to her friend **Lindsey (G)** [see Lindsey's perspective in Box 10]

PHEV assessment: Payback and the environment

For Brett, the idea of a PHEV is about "using as much electric as you can, but still having the engine so you're not dead at the side of the road with no battery." Julie agrees and particularly likes the idea of getting 45 mpg. The Forts mention two main motives for their interest in a PHEV: fuel savings and environment. Brett highlights cost savings, particularly the metric of return on investment—which he often applies to work projects—by calculating the payback of gasoline savings relative to the $10k price he discovered for the Hymotion upgrade. [He was actually talking about payback analysis]. He estimated that even if he saves $100 a month on gas, it will take 10 years to payback, which is much longer than the three year "rule of thumb" he uses at work. Julie adds that they might be more flexible about the payback period "if it's helping the environment," and Brett seemed to concur. Still, Brett explains that he probably would conduct such a calculation in detail if he was considering the purchase of an actual PHEV.

The Forts also consider the environmental aspects of the vehicle, and the wastefulness of vehicles with lower gas mileage. Brett is skeptical about the purported environmental benefits of electric-drive vehicles ("batteries are really nasty to make…and then you still have to make electricity") but from his experience working at power plants he thinks that such plants "control the exhaust a lot better than a car does." Julie is more convinced of the environmental benefits:

"if [the PHEV] was in a bigger car, I would definitely think about it…I'm sure they'll get there eventually…and it's not just for gas…it's for the environment too…I still think even if you weighed [electricity impacts], it would be better."

Brett and Julie link their growing environmental concerns to their household practices—describing how Selena has recently led their household to become more environmentally aware in general.

Surprisingly, by the end of their PHEV trial, the Forts seem to be far less concerned about safety from a vehicle mass standpoint. As Selena became more excited about the Prius' functionality and environmental benefits, she was less vocal about safety. Because she was the primary champion of their previous large vehicle purchase pattern, her shift in values seemed to influence the others. However, Julie only has experience driving larger vehicles, and maintains some reservations about driving a smaller car by herself. But the Forts seem to have no problem with buying a small HEV or PHEV for Brett, or with using such a vehicle for family trips.

Why do the Forts conclude with pro-societal interpretations?

The Forts quickly understand the basic functions of the PHEV. Brett has a technical career and has worked at a power plant, and has several HEV and EV owning co-coworkers. He and his family easily adapt to the PHEV's functions, recharging regularly and understanding that electricity use offsets gasoline use. Brett has also previously talked to coworkers about the environmental impacts of electricity generation and battery production. This functional foundation allows the Forts to seriously consider the societal implications of such a vehicle.

Another important factor is that the Forts sustain a state of lifestyle liminality. The four of them form a tight family unit; their social circles closely overlap, and they typically consult only one another regarding vehicle purchases and other issues. This closeness may result from Brett's lack of extended family, and the spatial distance of Selena's extended family who mainly live in Hawaii. This insular social arrangement buffers the Forts from external social pressures and allows them try out alternative and perhaps contradictory lifestyle practices. For instance, the Forts consume a large amount of energy: they own and operate three of the largest light-duty vehicles available and dream of a Hummer H2, they haul and drive dirt bikes and ATVs, and they live in a large home that requires a 60 mile roundtrip commute for Brett and over 30 miles of school commuting for Julie and Rex. Yet the Forts have begun to consider alternative consumption patterns, particularly as Selena has begun to shift their household practices to be more in line with Oprah Winfrey's pro-environmental messages. This environmental interest also seems to be motivated by exposure to the attitudes they encounter in the pro-environmental city of Davis, where Julie and Rex attend school. At the same time, Brett taps into the rational, financially-motivated value system of his technical workplace, prompting him to consider the PHEV according to financial payback. In this sense, the Forts' assessment of the PHEV is drawn from at least three value systems without committing to any one: "bigger is better" living, reducing environmental impacts, and rational cost savings. Without strong commitments to any particular social groups that emphasize these values, the Forts see nothing wrong with blending such different considerations—even in desiring such contradictory symbols as the Prius and Hummer.

Further, as a tightly-knit household, the Forts explain that their most influential social experiences occur with close family, and they don't typically don't look beyond each other when considering vehicle purchases. Indeed, most of their conversations about the PHEV took place with one another. However, Selena explains they were initially worried about the Prius being viewed as a "weenie car" (as it very well might have by some of their off-roading friends), yet they were surprised to find mostly positive reinforcement by acquaintances and strangers. This support served to further legitimize their growing environmental interests and commitment to pro-societal practices—even overriding their previous private-motivated focus on personal safety.

6.4 Discussion: Looking across narratives

To explore the social conditions that support a household's consideration of and potential transition to pro-societal values and lifestyle practices, this chapter summarized narratives from each of the 11 social networks observed in this study, focusing on four networks that considered a shift between private and societal values. For each narrative I consider the three social conditions identified at the end of Chapter 5—liminality of there lifestyle at the time of their PHEV trial, a functional understanding of PHEV technology (whether prior or acquired during their PHEV trial), and support for pro-societal values somewhere in their social networks—which help to explain why some household gravitate towards pro-societal interpretations of the PHEV.

First, if the household is not already engaged in a pro-societal lifestyle, their lifestyle must be in a liminal state to permit them to consider alternatives to their current (typically, private) lifestyle. In some cases, liminality is a temporary state of transition: Billy Woods was recently divorced and seeking new ways to structure his life, while Ed Ranchero recently married Silvia and together they were figuring out their lives in the context of starting a family. In time, such lifestyles are likely to return to a more solidified, stable state. In other cases, liminality can be sustained. Ethel Potter's liminality increases over time as her children move out and her disposable household income rises, giving her the time and resources to consider pro-societal actions and investments. The Forts' sustained liminality results from their social network structure: as a family unit they are tightly connected through mutual activities and communication while at the same time having access to many different types of networks (Brett's co-workers, Selena's friends, ATVers), settings, and influences. Their tight central family is maintained as a safe place for experimentation with ideas from these diverse sources.

Although liminality seems necessary for a household to consider pro-societal values, liminality does not need to be sustained after such a transition takes place: the Rhodes' and McAdams' have solidified their lifestyles around their pro-societal values, but now live in a less liminal state. Further, while liminality permits open-mindedness towards different interpretations of the PHEV, the condition is not sufficient to inspire an individual or household to consider pro-societal values. For instance, Betty Earhart's recent break-up and household transition and the student lifestyles of Katrina Petrov and Melissa Stashe can each be described as liminal states. However, none of these participants seriously considers pro-societal interpretations of the PHEV or a commitment to pro-societal practices or values due to absence in at least one of the other two conditions.

The second condition is a basic functional understanding of the PHEV technology. The household does not need prior experience or familiarity with electric-drive technology, nor do they need to be electric-drive experts or enthusiasts. However, observation suggests that an individual or household must at least understand the very basics of what a technology does, e.g. plugging in, before they can seriously consider who it is good for, that is, before they can frame its benefits according to private versus societal impacts. In the context of this study, primary households are more likely to consider societal impacts if they can easily grasp the most basic functions of the PHEV, e.g. that plugging it in can offset gasoline use by using electricity. The technical backgrounds of all four "pro-societal explorer" households facilitated such quick learning: Billy Woods was trained as an engineer and experienced with computer technology; Ed Ranchero worked as an engineering consultant; Ethel Potter had long been interested in science and frequently experimented with new practices; and Brett Fort worked as a computer engineer. Several "private lifestyle" households were slower to grasp the PHEV's functions: the Noels, the Petrovs, and Melissa Stashe had a more difficult time articulating the functional benefits of owning a PHEV. However, this functional understanding condition is also not sufficient for consideration of pro-societal values: Betty Earhart and Darren Stashe were quick to understand the PHEVs functions, but had little interest in pro-societal values.

The third condition is a demonstrated support of pro-societal values within the social network. Among the “societal explorer” households, the presence or absence of such support is associated with their final interpretation of the PHEV. The two households concluding with private interpretations described a lack of pro-societal support: Billy Woods referred to the financial motives of an influential group of coworkers, and Ed Ranchero was disappointed by the lack of interest among his friends and coworkers in the PHEV or its environmental impacts. In contrast, the two households that concluded with pro-societal interpretations of the PHEV perceived social support: Ethel Potter described pro-societal interest among her favorite daughters and a new friend from her pottery class, while the Forts were pleasantly shocked to see Prius owners welcome them to “the family.” Further, none of the “private lifestyle” households reported significant support for pro-societal values within their social networks—only the Stashe’s described one distant acquaintance with such interests.

Within the context of this study, these three conditions appear to be associated with households’ consideration of a shift towards private-societal values. However, it can be difficult to infer causality. For instance, a plausible concern about the functional understanding condition is that households exploring pro-societal values may be motivated to quickly learn about PHEV functions, not the other way around. A second concern relates to social support and Manski's reflection problem (Section 3.1.3): it is unclear if alter support causes a household to adopt pro-societal values or if such support merely reflects the household's tendency to interact with like-minded alters. In-depth exploration of such concerns must be left to future research, though the causal framing of the narratives themselves provides compelling insights in the meantime.

Relating to the first concern, the three households finding difficulty understanding PHEV functions—the Noels, the Petrovs and Melissa Stashe—did not experience such difficulty due to a lack of effort. Each of these participants was excited about he PHEV throughout their trial, and exerted at least as much effort to explore it as did other households. Their difficulty seemed to stem from a lack of technical background, or access to others with technical background, rather than indifference resulting from a lack of pro-societal interest. This tendency suggests that functional understanding was indeed a condition that set up pro-societal consideration—not the reverse.

For the second concern, the reflection problem, this narrative approach assesses causality be directly eliciting participants' accounts of their experiences. Billy Woods explained that before he polled his coworkers about pro-societal values, he was uncertain about his own interpretations—according to his own story, his coworkers' response was not just reflecting his interpretation, but instead helped him to shape it. Similarly, Selena Forts' explains how she changed her perception of the Prius as a "weenie car" after finding support from unexpected alters, and a lack of ridicule among others. In Selena's words, such experiences were casually related to her pro-societal assessment of the technology.

Numerous other examples illustrate this point, where individuals are sometimes aware that they have shaped their own PHEV interpretation according to social interactions with others.

Perhaps even more difficult than determining causality is assessing the magnitude of influence exerted by each factor. Because I only know one narrative about each social network, it is impossible for me to conduct a sensitivity test—adding or removing different conditions to see if participants' PHEV assessments change. As an interesting exercise, I can speculate by considering counterfactuals: what might have happened if the observed conditions were different. Such an exercise requires that I use the researcher, myself, as a research instrument (as described in Section 3.5.6)—using everything I have learned about the household to consider alternative scenarios. For instance, if Billy Woods' coworkers had emphasized pro-societal values, would Billy have re-framed his PHEV assessment to focus on pro-societal benefits? From what I have learned about Billy, such an outcome is plausible. In several cases, Billy accepted his alters' observations and assessments as his own, such as when his friend Albert complained about the Prius' engine noises at higher speeds. If this key group of influential coworkers had espoused pro-societal interpretations of electric-drive vehicles, Billy may very well have adapted his own interpretation accordingly

I might also consider a reverse counterfactual with the Forts: if the Forts had not discovered pro-societal support within their network, would they still have maintained their pro-societal interpretations of the PHEV? On one hand, given the Forts' demonstrated insularity from most external influence, they might well maintained their pro-societal interest even in the face of ridicule. On the other hand, the Forts' memorable, emotional interactions and experiences, e.g. the waving Prius owners, seemed to play a particularly important role in helping them overcome previous fear-driven concerns of vehicle mass and safety. So while it is not clear if such instances of pro-societal support were required for the Forts to assess the PHEV as they did, these experiences at least seemed to contribute to the observed outcome. Perhaps most important is that these narratives begin to depict the complexity of the role social influence can play in vehicle assessment and potentially in vehicle purchase behavior.

Similar to the conclusion of Chapter 5, this discussion highlights the complexity of social influence processes. The next chapter seeks to integrate the knowledge gleaned from these research findings, as well as the five research perspectives reviewed and Chapter 2 and applied in Chapter 5, into a useful theoretical framework relating to vehicle assessment and purchase behavior.

7 An integrated perspective: Reflexive layers of influence (RLI)

In this chapter I consider how insights gleaned from this dissertation's literature review of five theoretical perspectives and empirical observations of social networks can be used to construct an integrative theoretical perspective on the role of social influence in vehicle purchase behavior. Of course, such a behavioral perspective should not only represent processes of social influence; in Section 2.1 I note Jackson's (2005, p.x) suggestion that "a useful model has to account for: motivations, attitudes and values; contextual or situational factors; social influence; personal capabilities; and habits." Before proposing an integrative perspective in this chapter, I first revisit the five perspectives of social influence reviewed in Chapter 2 and applied in Chapter 5, and discuss how they relate to the three conditions identified in Chapter 6 that support household consideration of pro-societal values. Next, I propose an integrative theoretical perspective, which I call reflexive layers of influence (RLI). I define and conceptualize a framework for RLI, including the object of interest, the social system, and the drivers of social influence, technology assessment, purchase intention and adoption. Finally, I illustrate this model by applying it to three of the narratives constructed from participant PHEV trial experiences.

7.1 Revisiting the five research perspectives on interpersonal influence

To begin, I consider how the three conditions identified in Chapter 6 (lifestyle liminality, functional understanding and social support) relate to the five perspectives on interpersonal influence outlined in Chapter 2 and applied in Chapter 5 (contagion, conformity, dissemination, translation, and reflexivity). Table 16 lists the concepts from each perspective as I relate them to the three conditions.

Table 16: Relating concepts from the five perspectives to the three conditions

Perspective:	**Conditions supporting the consideration of pro-societal values**		
	1. Lifestyle liminality	**2. Functional understanding**	**3. Social network support**
Contagion	Adopter categories	Diffusion of knowledge	Persuasion
Conformity	Threshold	Social learning	Thresholds, social learning, social norms
Dissemination		Dissemination of awareness knowledge	Achieving pro-societal goals
Translation	Interpretive flexibility	Framing, defining problems	Reaching interpretive closure or alignment
Reflexivity	Project of the self		Validation of lifestyle practices

First, contagion views interpersonal influence as primarily occurring through the flow of information. The diffusion of information (DOI) approach identifies two types of information: knowledge and persuasion. Most DOI research focuses on knowledge information, which includes awareness of the innovation and its basic functions. The present research highlights the importance of such functional knowledge as a base requirement for a household to consider pro-societal interpretations. Thus, there is value for researchers to understand how functional information diffuses through a social system. Prior to the primary household's PHEV trial, awareness and functional knowledge of electric-drive technology had diffused to different degrees within their social network, e.g. almost fully across the McAdams' social network, partially in Billy Woods', and hardly at all in the Noels'. The primary households' PHEV trial stimulated social interactions which diffused more awareness and functional information in each household, which ultimately influenced assessments made by the primary household and their alters.

DOI also discusses persuasion, where attitudinal information pertaining to the innovation is diffused from earlier adopters to later adopters. DOI does not explore or elaborate further on such processes, but the concept does relate to the condition of social support identified in this dissertation. DOI does not directly address lifestyle liminality, though it is related in the sense that individuals classified as innovators and early adopters are more open to new ideas and technologies (relating to higher liminality), while the later majority will follow along only when it is economically necessary or unavoidable (relating to lower liminality). On the other hand, DOI implies that innovativeness is static and that a given individual belongs to only one adopter category, suggesting that all buyers have stable self-concepts, or are in a state of low liminality. Of these links to the three conditions, the contagion perspective is most appropriate for, and has been more frequently applied to, the diffusion of functional knowledge and understanding.

Processes of conformity are driven by an individual's perceptions of what others are doing, what others expect, or what others value. Conformity most clearly relates to the social support condition, where an individual exploring pro-societal interpretations or values wants to perceive some degree of support among their alters. This process may be represented as a threshold, that is, the proportion of an individual's social network that must act (or approve of the act) before the individual will act. A simplified, quantitative representation of thresholds may be problematic for understanding this study's participants. Each primary household looked for a different level of support from different sections of their social network—I find no evidence of the clear, simple patterns represented in conformity models (e.g. Granovetter, 1978). Billy Woods would have found pro-societal support if he had more in-depth conversations with his coworker June or Harry, or his girlfriend—instead he polled one particular group of coworkers and conformed to their private interpretations. Ethel Potter perceived a lack of interest among most alters, but was inspired by pro-societal support from two daughters and a pottery class acquaintance. The Forts were particularly motivated by the affirming non-verbal gestures of strangers driving a Prius. In these examples, each household's threshold for pro-societal commitment is unique. There are different thresholds for different information and behaviors for different parts of each household's social groups.

Further, it is not clear if such thresholds are driven by processes of social learning—learning functional information by observing others' outcomes—social norms—perceiving what others think is desirable or proper behavior—or other processes. The conformity perspective's notion of social learning may also apply to the functional understanding condition, where household understanding may increase with the presence of previous adopters that can demonstrate the PHEV's benefits. Lastly, similar to DOI, conformity does not directly address lifestyle liminality, other than the assertion that people with lower thresholds require less social support to try out new behaviors. In other words, an individual with a lower threshold is more open to change than someone with a higher threshold.

Dissemination involves intentional diffusion of information by an organized group seeking to achieve pro-societal goals, and directly relates to the conditions of functional understanding and social support. The McAdams and the Rhodes serve as informal disseminators; they actively disseminate functional (and symbolic and pro-societal) information about electric-drive vehicles and other pro-societal technologies in effort to promote further adoption. One reason such households seek and act to create social support for pro-societal practices is that they are more likely to achieve pro-societal goals if others follow suit. Some other households may have hoped to become disseminators—Ed Ranchero and Ethel Potter were clearly disappointed that more alters were not interested in the PHEV or its pro-societal properties. Such disappointment may be driven by more than just a desire to show off, but also a desire to influence the pro-societal values of others (though this desire is not strong enough to actively seek out new alters).

Translation represents how social groups negotiate different interpretations of a new technology, and directly links to all three conditions. Social groups and individuals that are in a state of lifestyle liminality may be more likely to be in a state of interpretive flexibility. Their liminality might not affect how they assess the PHEV's ability to save money, but it may affect how they weigh different benefits, e.g. private versus societal, based on how the benefits connect with a particular self-concept. Second, a social group or individual's functional understanding of the technology may influence how they frame their interpretations and the problems it might solve. Third, when a social group or individual finds some degree of social support for their interpretation, the initial state of interpretive flexibility transitions to a state of closure or alignment. Social groups that coalesce around a particular interpretation may then become less liminal.

Finally, reflexivity relates to lifestyle practices: how an individual seeks to arrange their experiences and activities into a meaningful trajectory. An individual may be in a state of liminality if they are not fully committed to a particular lifestyle, and in this state they seek a sense of order. They experiment with a new storyline, and view the responses of alters to determine if such lifestyle practices fit or if they need to keep trying. Thus, if the individual is not already committed to pro-societal values and lifestyle practices, they must be in a state of liminality in order to consider and experiment with such values. The individual will then only commit to pro-societal values if they find adequate social support. Alternatively, the individual's lifestyle or self-concept may be committed to a high degree of liminality—and thus they sustain liminality.

Similar to the conclusion of Chapter 5, this discussion again highlights the differences of the five perspectives on social influence, each of which focuses on different aspects of the three social conditions highlighted in Chapter 6. Now I seek to integrate the knowledge gleaned from each of these perspectives and the present research findings into a useful theoretical perspective and conceptual framework.

7.2 An integrative perspective: Reflexive layers of influence (RLI)

In this section I introduce a new framework to represent social influence, which I call: reflexive layers of influence (RLI).When I reviewed the five perspectives on social influence in Section 2.3, I first outlined a five question framework of inquiry inspired by Bruun and Hukkinen (2003):

1. What is the innovation, and what attributes are important?
2. What are the system boundaries?
3. Who adopts earlier, and why?
4. Who adopts later, and why?
5. What drives adoption from earlier to later adopters?

This section is organized to explain RLI according to each question, that is, conceptualizing the new object of focus, the system boundaries, how to differentiate earlier adopters from later adopters, and the processes of social interaction that drive adoption. Where appropriate, I borrow and adapt terminology and concepts directly from the five perspectives previously reviewed and discussed—though in doing so, I carefully redefine each term for the present application in RLI (typically to be more generalized). At some points I propose new ideas suggested by observations in this study. In all cases, my use, application and integration of concepts is unique from the reviewed five perspectives on interpersonal influence. I bold each term as I introduce it in the RLI context, and Table 17 at the end of this section provides a glossary of these RLI terms. Figure 35 visually depicts the basic RLI framework.

The RLI framework is intended to be an integration of concepts that is accurate, parsimonious and useful in application to consumer adoption behavior. In this discussion I attempt to frame this model as generally as possible—allowing application to a variety of products with potential pro-societal benefits.[14] However, I place particular focus on the case of pro-societal vehicles.

7.2.1 The innovation as a dynamic, socially-defined artifact

In analyses of pro-societal cars and similarly complex products, RLI describes the new pro-societal car as an artifact (as borrowed from the translation perspective). While the term innovation is rooted in and often confounded with the process of invention and development, the term artifact highlights the culturally-embedded, socially-defined nature of the technology. In RLI, a **new artifact** is defined as an object that actors may associate with one or more ideas that they perceived as novel on functional, symbolic and/or societal dimensions. Over the course of the adoption process, the new artifact may be physically altered and its functional, symbolic and societal attributes may be reinterpreted by actors within the relevant social system.

[14] Potentially, RLI could be adapted and applied even more generally to pro-societal behaviors and practices, e.g. recycling or eco-driving, in addition to purchase behavior. However, I leave further consideration of this possibility to future research.

This definition is not concerned with whether the artifact is itself physically new; what matters is the new idea(s) associated with it. In the context of vehicles, a new artifact may be framed within several relevant hierarchical layers, such as the specific technology (e.g. HEV drivetrain), the technology group (e.g. electric-drive vehicles), and the overarching vision or idea (e.g. a pro-societal car). An actor's perception of what is new about the artifact helps them to frame their interpretation of it.

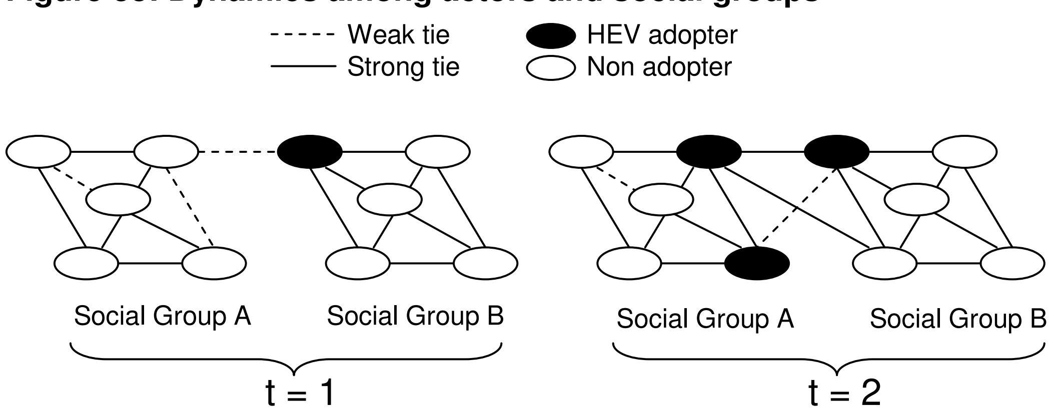
In observing adoption over time, the dynamic nature of the artifact is also recognized. Again, the importance lies in the dynamics of consumer perception of attributes and ideas, not necessarily physical alteration. For instance, an improvement in the drivetrain of a particular PHEV only matters if this change is perceived to impact the associated idea(s), such as increasing fuel savings (private-functional), reducing emissions (societal-functional), or better communicating a nationalistic message (societal-symbolic).

7.2.2 System boundaries: Dynamics in the relevant social system

RLI employs the term **actor** as a scalable unit of analysis—it can be an individual, a household, a family, a group of friends, a company, a government or any other kind of social group that is relevant to the artifact in question and may at times act as single unit. The actor may be an adopter, observer or manufacturer of the artifact, or in some other way holds stake in its adoption (or non-adoption). I use the term **social group** to distinguish a group of actors from an individual actor. Unlike actor-network theory (ANT), the RLI notion of actor is limited to human beings and does not include objects such as the artifact or its components. Human beings differ from objects in important ways—particularly in their ability to form and negotiate interpretations of the artifact (whereas the artifact does not form and negotiate interpretations of human beings or other objects). Thus, I argue that actors and artifacts deserve distinct terminology.

The presence of, and relationships between, relevant actors can shift over time—sometimes as a result of the new artifact itself. For instance, Figure 33 depicts a hypothetical situation where, prior to an individual actor's adoption of a new artifact, a weak link exists between two social groups (A and B). The use of this artifact by an adopter in social group B then stimulates conversation and interest from a socially distant alter, say a casual acquaintance, in social group A. This interested person tells a close friend in his own network, and after they both adopt, new social ties develop between the two networks, and the originally weak social tie is strengthened. The PHEV trial helped stimulate such patterns in the social networks of Ethel Potter and Larry Rhodes, where the primary household became socially closer to a pottery classmate and a fellow martial arts student, respectively, after engaging in conversations about the PHEV.

Figure 33: Dynamics among actors and social groups



Also, as suggested by specific approaches with the diffusion (DOI) and translation (SCOT and ANT) perspectives, an actor's decision to adopt a new artifact is influenced by more than just the actions of other individuals in their social-network—governments, industry, media and other groups can play a role also. Thus, an analysis of the adoption of an artifact with complex, dynamic attributes must include a broad notion of the **relevant social system**. This system includes all individual actors and social groups that can influence potential adopters' interpretations of the new artifact, including previous adopters, observers, manufacturers, media, interest groups and governments. Over the course of the adoption process, the relevant social groups may be physically altered (through the addition or removal of members), or reinterpreted on functional, symbolical or pro-societal dimensions (like the new artifact itself). For instance, a group of actors may form around a new idea pertaining to PHEVs, such as oil independence, and their negotiated functional, symbolic and pro-societal interpretations of PHEV may change as more group members adopt and interact.

7.2.3 The timing of adoption: Aligning context and actor interest

Determining if and when an actor adopts a new artifact involves the interaction of several factors, which RLI divides into concepts of contextual factors—like the notion of structure—and individual factors possibly more immediately controllable by the actor (within the specific episode of contemplating a new artifact)—similar to the notion of agency. **Contextual factors** can include the actor's:

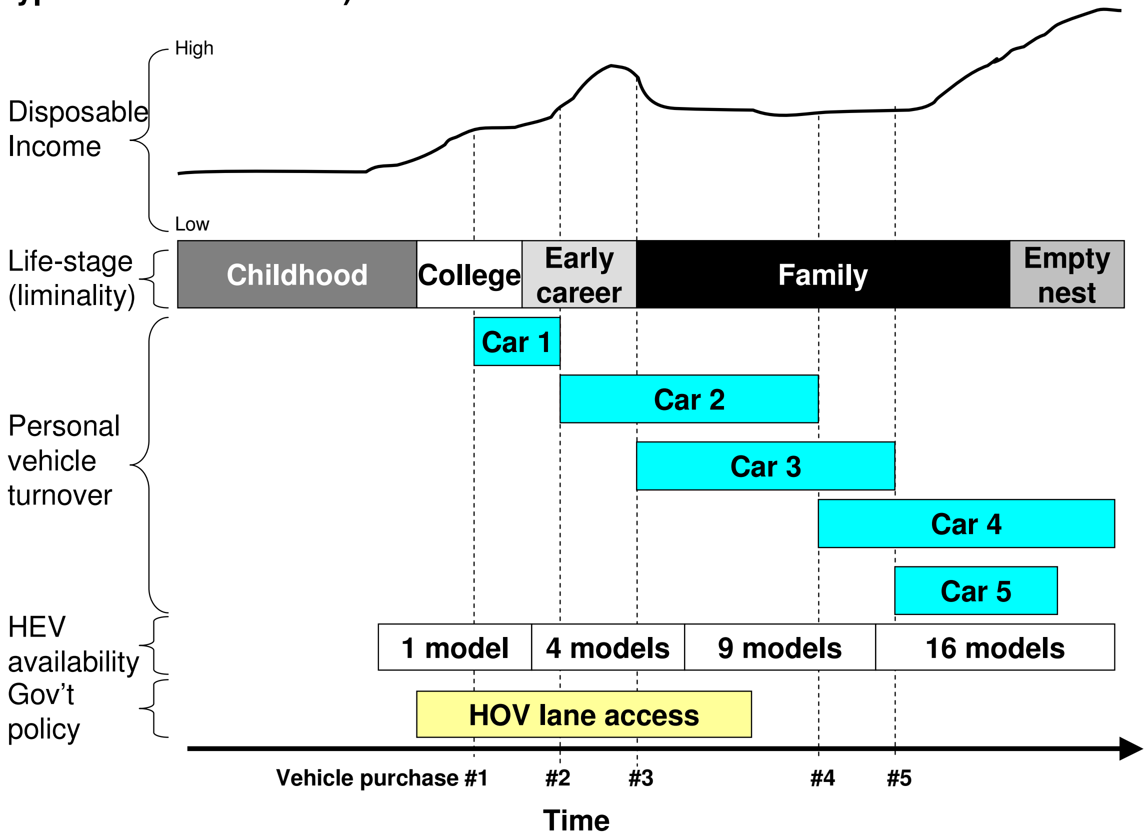
- disposable income;
- life stage, e.g. student, career, young family, or retired; and
- cycle of stock turnover, i.e. when a new artifact is needed or when an incumbent artifact needs to be replaced or displaced.

Contextual factors also include characteristics of the market, such as:

- price of artifact;
- availability of the artifact, including variety of models and features, dealership location, supply constraints and waiting lists;
- government policy relating to the artifact, e.g. tax rebates, special privileges, codes and standards; and
- marketing and advertising, or more generally, messaging, efforts related to the artifact.

The importance of contextual factors is illustrated for a hypothetical vehicle buyer considering an HEV (Figure 34). This figure plots the actor's timeline, including life stage, vehicle ownership, vehicle availability (variety of HEV models), and government support (high-occupancy vehicle lane access for HEVs). The figure also depicts the lifestyle liminality associated with each life stage for this particular actor, where lighter rectangles indicate higher **lifestyle liminality**—that is, a greater openness towards new self-concepts and lifestyle practices.

Figure 34: Contextual factors influencing timing of vehicle purchase (for a hypothetical individual)



The timing of HEV purchase, if it occurs at all, could be influenced by many factors other than the individual's motives or interests (agency). The actor's first vehicle purchase may not have been an HEV because, as a college student, they had little disposable income, or the only HEV model available was not suitable for their functional needs, e.g. camping and recreation, or symbolic needs, e.g. it didn't look sporty enough. Contextual factors were more supportive of an HEV for the actor's second vehicle purchase: the actor had more disposable income, more HEV models were available, and the actor became aware that such vehicles were granted access to high-occupancy vehicle (HOV) lanes. The actor's third and fourth vehicle purchases were motivated by increasing family commitments, with less disposable income, and increased focus on vehicle features that are not associated with any of the HEV models available at the time, e.g. interior spaciousness. Further, the government no longer offered the HOV-lane incentive. Years later, as the children moved out, the actor may have had enough disposable income to again consider one of the many HEV models that had become available. However, at that time, the actor did not need a new vehicle. The point of this illustration is that given the complex interactions among contextual factors even in this simplistic example, it is a mistake to attribute the timing of new vehicle adoption to individual factors alone.

Of course, within this context, characteristics of the actor—or agency—also matter. Under the RLI framework, there are two main antecedents to an individual's **internal motivations** and intention to adopt an artifact: awareness and positive assessment. First, the individual must have **awareness knowledge,** i.e. knowledge that the artifact exists and is available for sale, and have some basic **functional understanding** of what it does, e.g. that a PHEV plugs in and/or can offer increased fuel economy. Such basic awareness is required before a stable assessment can be formed.

Second, the individual must somehow form a positive assessment of the artifact—perceiving functional, symbolic and/or societal interpretations that they feel are, on net, desirable from their own perspective and fitting in with their self-concept. An **assessment** is the actor's overall judgment of the artifact, which I divide into two potential components: **private assessment** (how the artifact might benefit the actor), and **societal assessment** (how the artifact might benefit other actors or society). The actor's overall assessment may be based only on one component, or some combination of both components.[15] An assessment is informed by one or more **interpretation**, which is a sub-component of an overall assessment and relates to specific functional or societal benefits (or dis-benefits) of the artifact. For instance, the Noels conclude with a positive private assessment of PHEV based on their interpretations that it can save them money and reduce trips to the gasoline station.

At a given point in time, an actor's interpretation(s) relating to the artifact may be completely non-existent, flexible, or stable. Interpretations are non-existent if the actor is not aware of the artifact's existence. Once the actor becomes aware, they typically start to form some interpretation(s) of what benefits the artifact might offer. The actor's interpretation(s) remain **flexible** when they have little information about and experience with the artifact. For instance, the actor may be unsure of what the artifact offers, and/or uncertain if the associated benefits will actually be delivered. The actor's interpretation(s) may become **stable** with increased information, experience or a convergence of interpretations among relevant social groups. If an actor forms a stable, positive assessment of the artifact, subject to the contextual factors noted above they may form an intention to adopt the artifact, and perhaps eventually purchase it.

The primary driver of the actor's assessment is their **self-concept** relating to their lifestyle practices and trajectory. Thus, assessment is not likely to follow the rational, deliberative process represented by behavioral perspectives such as the rational choice

---

[15] Assessment is consistent with the typology of consumer perceived benefits presented in Table 2 of Section 1.4, that is, according to the functional/symbolic and private/societal dimensions. In the context of this study, I find it convenient to only differentiate between private and societal assessments—largely because this study was not effective in identifying symbolic interpretations. However, the RLI framework could be extended to differentiate symbolic assessment.

model—unless the actor conceptualizes himself as a rational, deliberative person. The actor's self-concept and lifestyle shape what aspects of the artifact they perceive to be important, thus shaping their interpretation(s) and assessment(s) of the artifact. Their overall assessment is positive if the artifact and its interpretations are perceived to align with their self-concept and perceived lifestyle trajectory—even if the interpretations are based on inaccurate or ill-formed information. At the same time, interpretation and assessment processes reflexively influence the actor's self-concept and lifestyle trajectory. In short, the actor's self-concept is itself dynamic.

To identify contexts in which an actor's self-concept is more subject to change, I borrow the notion of lifestyle liminality as summarized in Section 2.3.5 (Turner, 1969). In RLI, an actor has a **liminal lifestyle** if their self-concept is ambiguous, in a state of transition, and/or open to change. Such an actor is not firmly committed to a well-defined set of lifestyle practices. Liminality may be associated with numerous factors, such as: the actor's life stage; their commitments and responsibilities; their access to resources such as time and money; the degree of routinization of their lifestyle practices, e.g. work time and location; and access to a diversity of values and lifestyle practices through interactions with a diverse social network.[16] In contrast, an actor's self concept is relatively **stable** if they are committed to a well-defined set of lifestyle practices. A key point here is that liminality varies across actors and over time for a particular actor according to a variety factors, including external factors.

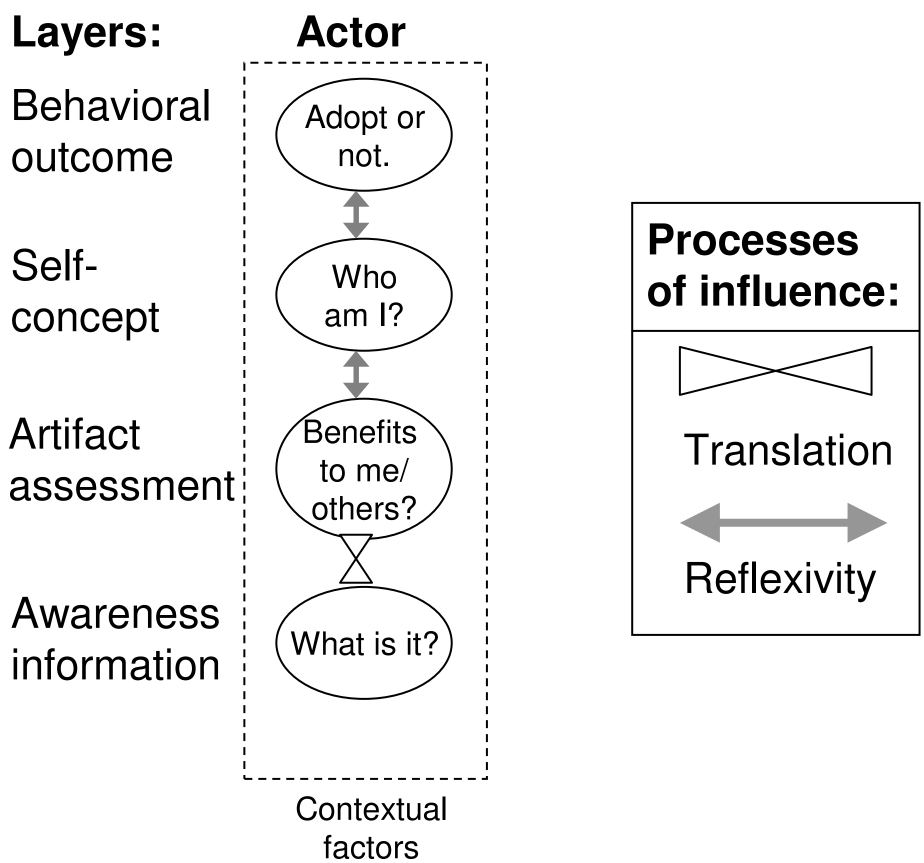
[16] It is beyond the scope of this dissertation to sort through such potential factors—the intent here is to invigorate the theoretical possibilities of this concept.

Ultimately, the timing of adoption is driven by a correspondence of structure and agency, or between contextual factors and internal motivation. Adoption occurs through the temporal alignment of factors that are external and internal to the actor. Contextual factors include the actor's disposable income, life stage, the turnover of their artifact stock, the availability and functional development of the artifact, and the actions of government, marketers and others actors in their social system. Internal factors include the actor's awareness of artifact and what it does, and their formation of stable, overall positive private and/or societal assessment of the artifact based on the functional and/or symbolic benefits it offers. Thus, adoption occurs when there is accord between the actor's interest and external opportunity.

7.2.4 Driving adoption: Layers of social influence

RLI describes assessment and adoption according to four basic layers. Building up from the bottom, those layers are functional awareness, assessment, self-concept, and behavior, e.g. purchase (Fig. 35). The placement of behavior as the top layers is analogous to an iceberg—it is the visible outcome that captures the attention of most behavior researchers, but a focus only on this "surface" neglects the important processes that occur below. The ordering of these layers is depicted according to an observed tendency: the stabilization of lower level (foundational) processes tend to be required before higher level processes can take place. For example, a stable assessment can only take place after the actor has become aware of the artifact, and translated functional information to form interpretation(s). The actor starts to reflexively relate the artifact to their self-concept as they start to form a stable assessment. Finally, purchase tends to occur once the actor somehow establishes that the artifact fits with their self-concept. Further, higher layers are associated with more complex interactions, while lower layers tend to be relatively simple. Despite this ordering, influence among layers can occur in multiple directions (not just bottom to top or vice versa) and at multiple points in time.

Figure 35: The basic layers of RLI



Processes of social influence tend to follow different patterns for each layer. Diffusion, translation and reflexivity offer complementary explanations, and I borrow concepts from each perspective and redefine each process for RLI. Figure 36 conceptualizes how social interactions regarding the different attributes of an innovation may fall onto a continuum representing the complexity of interactions. Some types of information are simple and static and their flow is better explained as diffusion, such as the awareness knowledge. Awareness knowledge flows in one direction (the sender does again become aware of the artifact) and is not significantly altered as it is passed among individuals. Diffusion also applies to simple functional information about the artifact, such as what it does. For RLI, I define processes of **diffusion** as occurring when simple information regarding the innovation, such as awareness knowledge, diffuses unidirectionally within and between social groups; the nature of such information changes little with each communication.

Figure 36: The diffusion-translation continuum

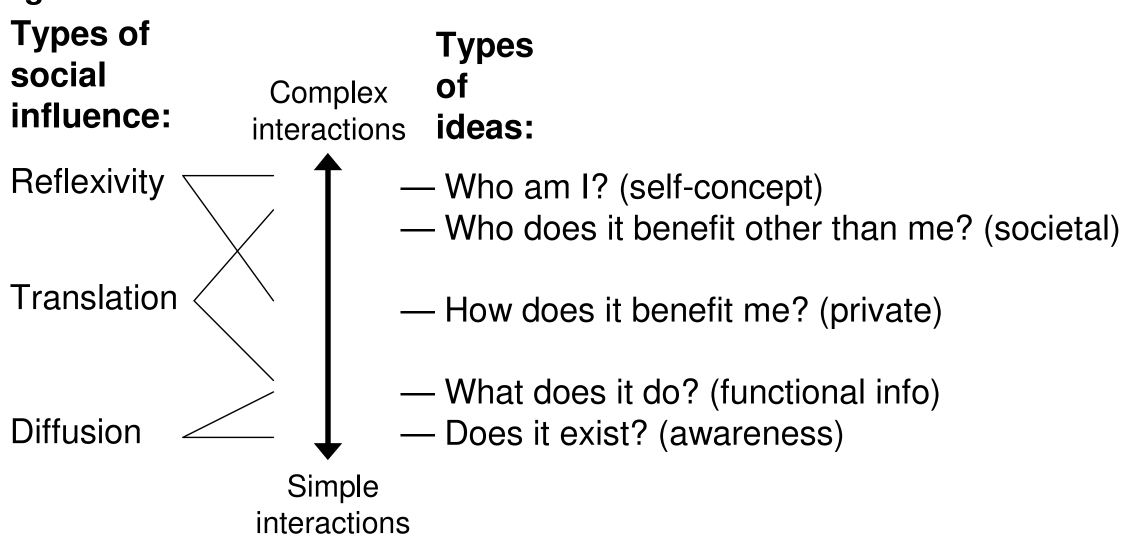


Figure 37 depicts processes of social influence as they relate to the four layers identified above. The flow of information relating to the actor's interpretation(s) and assessment(s) is characterized as **translation**—the interaction influence's the actor's assessment of the artifact within the actor's unique context of experience and self-concept. The content and presentation of the information and how it is perceived can change substantially with each communication, and information and interpretations may be translated in multiple directions during a social interaction. Further, interactions with relevant social groups can influence a given layer through **direct translation**, i.e. the content of the interaction directly addresses the assessment layer, or through **indirect translation**, e.g. the interaction content is diffused to the functional understanding layer, but the actor acts to translate this functional information into their unique assessment. For instance, information that PHEVs exist and can reduce gasoline use may diffuse from one actor to another. However, an actor may indirectly translate received information to inform their assessment of how such an artifact may benefit them, say, by saving money or reducing trips to the gas station. The actor's assessment is dynamic, and will continue to develop as more functional information is diffused to the actor, and can be directly influenced by social interactions with other actors in the relevant social system. Societal interpretations of the artifact can also involve complex social interactions relating to the actor's conceptualization of society and the artifact's potential role within it.

Further, influence at the self-concept layer constitutes reflexivity—where assessment, intention to adopt and purchase are driven by the project of the self, where the actor reflexively derives and develops interpretations of how different practices fit into their self-concept, and how the self-concept itself might change. For instance, the consideration of private versus societal assessments relates to the actor's self-concept, and may stimulate a reflexive process. Like translation, reflexivity can occur directly or indirectly. **Direct reflexivity** is when the content of an interaction directly addresses the actor's self-concept, such as two car buyers talking about whether they are motivated by financial savings or saving the environment. **Indirect reflexivity** is when an actor's self-concept is influence by content addressing other layers, such as if a car buyers' friend's comment that PHEVs are a great way to reduce GHGs (societal assessment) stimulates the car buyer to consider whether they should become more engaged in pro-environmental practices (self-concept).

Figure 37: The basic processes of social influence

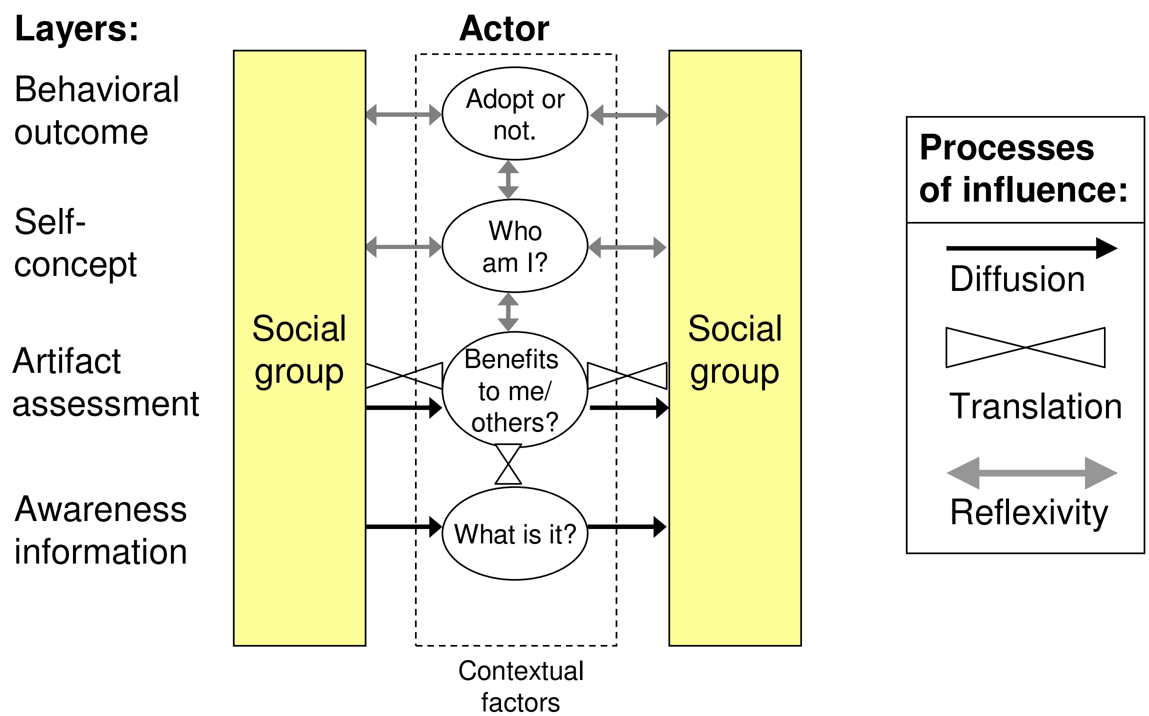
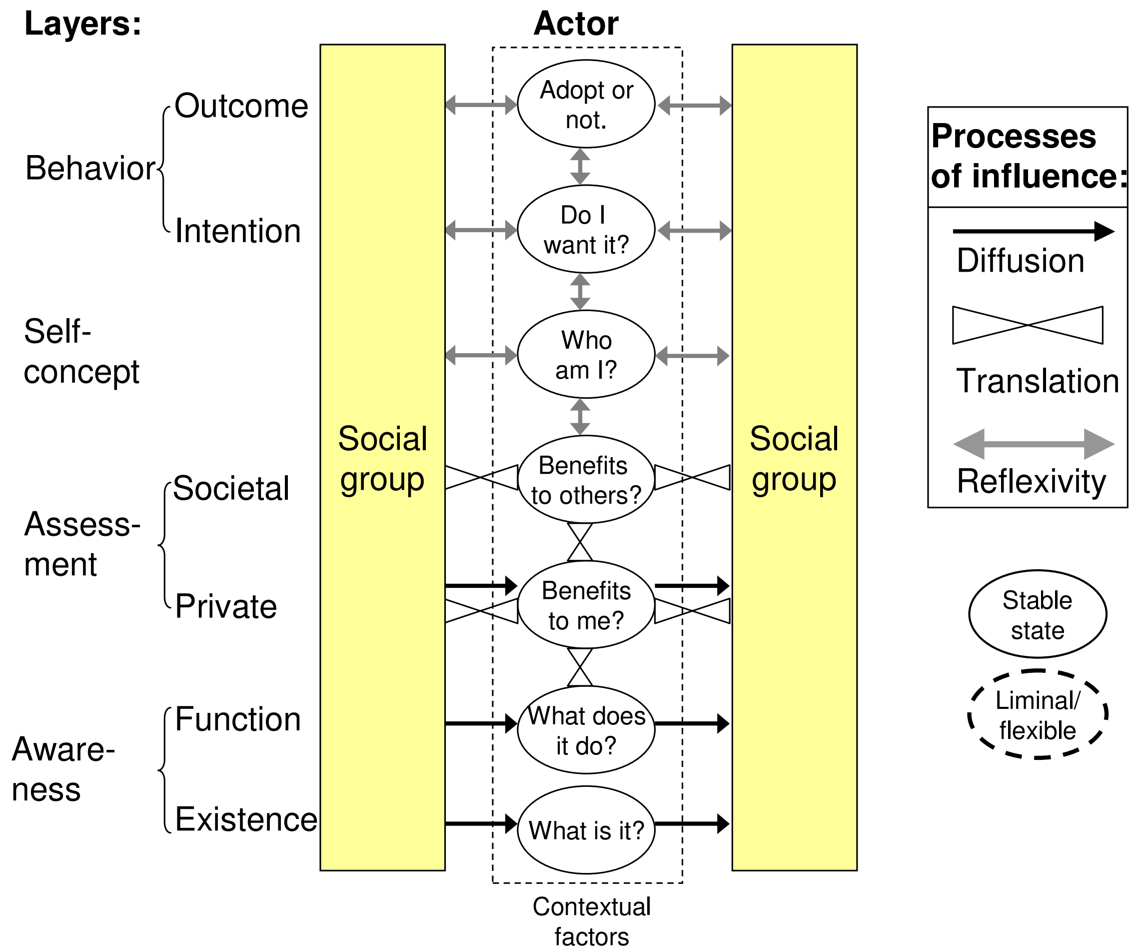


Figure 38 depicts a more complex representation of the RLI framework. The bottom, foundational layers are awareness and basic functional understanding of the artifact; this information may diffuse from or to other actors in the relevant social system. The next layer is the actor's private assessment of the artifact which can be indirectly translated from the functional information the actor receives, as well as directly translated through interactions with other actors. Diffusion also occurs at this stage when the actor simply assimilates interpretations from the others' assessments.

Figure 38: A more complex representation of RLI



Further up is societal assessment of the artifact, which typically requires awareness, functional understanding and some degree of private assessment to have taken place first. Influence relating to this assessment is primarily described as translation. In some cases, the actor does not consider societal assessment at all, thus skipping this layer. Next is the actor's self-concept, which is reflexively linked to all lower layers, to the self-concepts of other actors, and to the actor's behavioral intention relating to the artifact. Reflexivity is by definition dynamic, multi-directional and iterative, where self-concept may influence and be influenced by the actor's artifact assessment, behavioral intention and purchase behavior. For instance, if the actor identifies with an environmentalist self-concept, they may purchase an artifact they associate with helping the environment; by purchasing the artifact, they reinforce their self-concept of being an environmentalist.

The RLI framework accounts for all three conditions that relate to a household's consideration of pro-societal values (Chapter 6). Basic functional understanding is required before a more sophisticated private and/or societal assessment can be made. Further, pro-societal support within the actor's social network can occur through translation at the social assessment and self-concept layers. Lastly, lifestyle liminality is depicted at a given state of time by a dotted oval, and stability is represented by a solid oval. Similarly, a dotted oval at the private or societal assessment layers indicates the assessment is flexible, and again, stability is represented by a solid oval.

While this RLI framework integrates concepts from the diffusion, translation and reflexivity perspectives, it does not directly use terms from the conformity and dissemination perspectives. However, such concepts are still accounted for. Conformity can occur in multiple layers in RLI. Social learning can take place through the diffusion of functional information, others' private assessment, and others' behavioral intentions or purchase decisions. Similarly, social norms can be perceived and exert pressure through social interactions occurring at the assessment, intention and purchase layers. Dissemination can also occur when the actor includes a pro-societal motivation as part of their self-concept and then seeks to intentionally diffuse functional information or spread details of their positive private or societal assessment of the artifact to other actors.

Table 17: Glossary for reflexive layers of influence (RLI) framework

RLI term	Definition
The object:	
New artifact	An object associated with one or more ideas that are perceived as novel on functional, symbolic and/or societal dimensions. The new artifact may be physically altered and its functional, symbolic and societal attributes reinterpreted by within the relevant social system
The system:	
Actor:	An individual, household, family, group of friends, company, government or any other kind of social group relevant to the new artifact that may at times act as single unit. The actor may be an adopter, observer, manufacturer or some other stakeholder of the artifact.
Social group:	Distinguishes a group of actors from an individual actor.
Relevant social system:	Includes all individual actors and social groups that can influence potential adopters' interpretations of the new artifact. Over time, the relevant social system may be physically altered (through the addition or removal of members), or reinterpreted on functional, symbolical or pro-societal dimensions (like the new artifact itself).
Timing of adoption:	
Contextual factors:	Factors external to the individual that can influence their timing of adoption, such as household characteristics (disposable income, life stage, etc.) and market characteristics (artifact availability, price, etc.).
Internal motivation:	The actor is more likely to form an intention to adopt the artifact if they aware that it exists, have a basic understanding of what it does, and have formed a positive, stable assessment of the artifact that aligns with their self-concept.
Layers of social influence:	
Awareness knowledge	The actor is aware that the artifact exists.
Functional understanding	The actor has some basic understanding of what the artifact does, and how it is functionally different from incumbent artifacts.
Assessment	The actor's overall judgment of the artifact, with two potential components The actor's overall assessment may be based only on one component, or some combination of both components. An assessment is informed by one or more interpretations: *Private assessment*: how the artifact might benefit the actor *Societal assessment*: how the artifact might benefit other actors or society.
Interpretation	A sub-component of an overall assessment relating to specific functional or societal benefits (or dis-benefits) of the artifact. An actor's interpretation may be non-existent, in flexible, or stable.

	Flexible: when the actor has little information about and experience with the artifact. *Stable*: with increased information, experience or a convergence of interpretations among relevant social groups.
Self-concept	The actor's understanding of who they are, and how they fit into the modern world. The actor constructs an ongoing narrative of their lifestyle trajectory in order to inform and refine their self-concept. At any given point, their self-concept may be liminal or stable. *Liminal lifestyle:* the actor's self-concept is ambiguous and open to change. *Stable*: the actor is relatively committed to a well-defined self-concept.
Processes of social influence:	
Diffusion	Simple information regarding the artifact, such as awareness knowledge, diffuses uni-directionally among actors and social groups. Information content changes little with each communication.
Translation	More complex information, such as functional, symbolic and/or pro-societal interpretations, is translated to inform the actor's assessment of the artifact. Unlike diffusion, the content and presentation of the information and how it is perceived can change substantially with each communication. Multiple, multi-directional translations may occur during a single social interaction. *Direct translation*: content of a social interaction directly addresses the actor's interpretations and assessment (occurs between actors). *Indirect translation*: the actor translates other types of information into their assessment (occurs between layers for a given actor).
Reflexivity	The actor reflexively derives and develops interpretations of how the artifact might fit into their self-concept, and how the self-concept itself might change. *Direct reflexivity*: content of a social interaction directly addresses self-concept and values (occurs between actors). *Indirect reflexivity*: the actor reflexively considers their self-concept using other information (occurs between layers for a given actor)

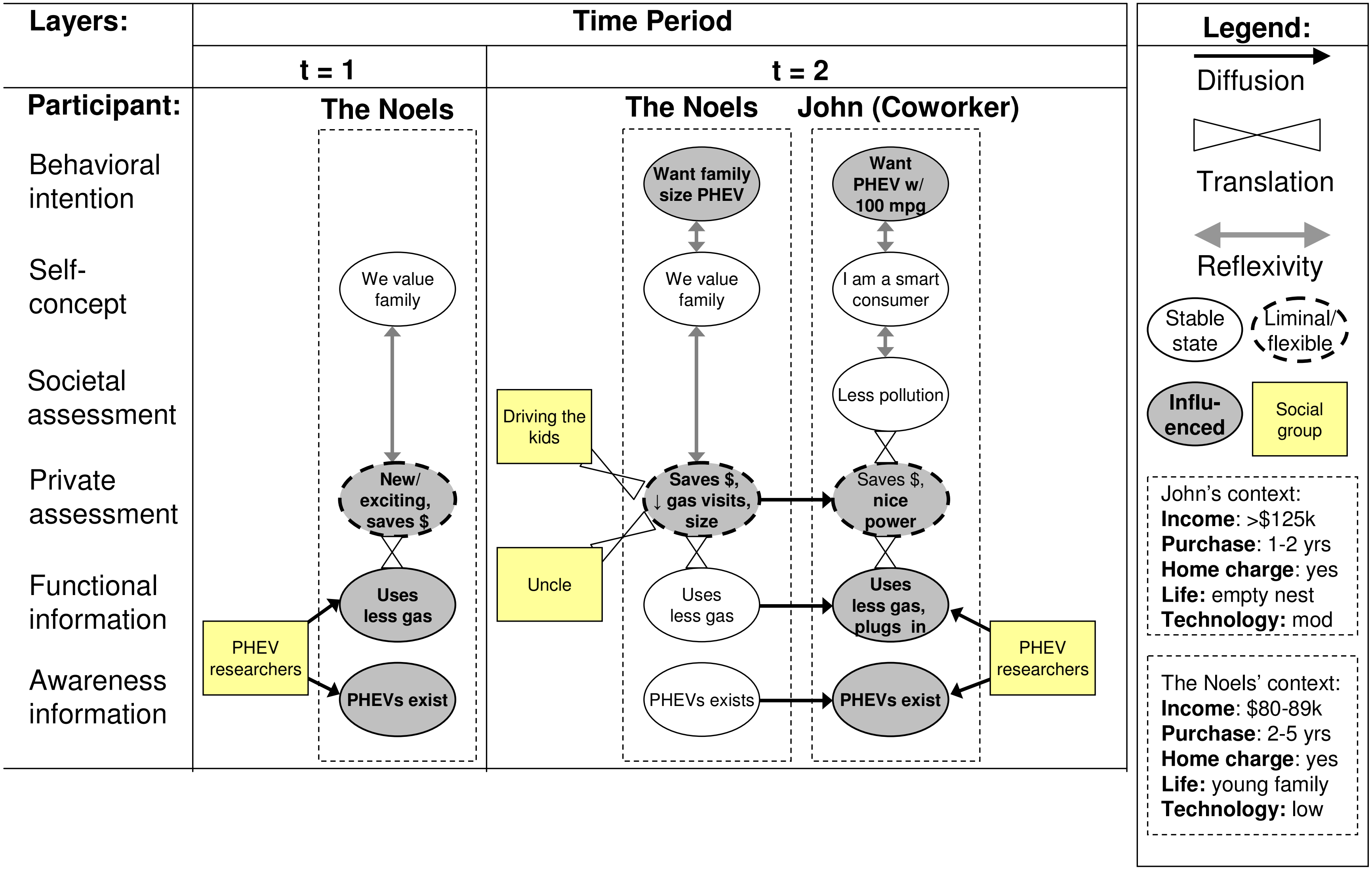
7.3 Applying the RLI framework

To illustrate the usefulness of RLI as an integrative behavioral framework, I apply it to three of the social networks observed in this dissertation: the Noels as a household with a stable, private self-concept; Billy Woods as a household considering pro-societal motives as part of his PHEV trial but concluding it with a private self-concept; and the Forts as a household that shifts their values in favor of a pro-societal self-concept over the course of their PHEV trial.

First, a simplification of the Noels' PHEV experience is depicted in Figure 39. In the beginning of their PHEV trial (t = 1), the Noels learned about the PHEV's existence and its basic functions from researchers. Upon learning that the PHEV could reduce gas use, the Noels' initially (indirectly) translated this information into their private assessment of saving money, which was implicitly linked to their fairly stable self-concept of being a family-oriented household. The Noels did form societal interpretations of the PHEV. By the end of their PHEV trial (t = 2), the Noels' private assessment had been influenced through several social interactions. When Amy's Uncle stated that the PHEV could help reduce trips to the gas station, she assimilated this interpretation into her own private assessment (a direct translation). Also, by driving their PHEV with their three children as passengers, the Noels learned that although such a vehicle was fun for the kids, the Prius was too small for their family—a PHEV would need to be larger. These private interpretations are indirectly reflexively linked with (and in this case reinforcing) the Noels' self-concept of being a family-oriented household. No alters referred to societal aspects of the PHEV, and this layer remained irrelevant to the Noels throughout their trial. From their assessment, the Noels form an intention to purchase such a vehicle subject to conditions that align with their family-oriented self-concept. Because this study did not observe PHEV adoption, it is unknown if the Noels will turn their intention into purchase at some point in the future. Ultimately, such a purchase would only occur with an alignment between the conditions of their behavioral intention (which may change over time), and the contextual factors such as model availability, purchase price, and their household income.

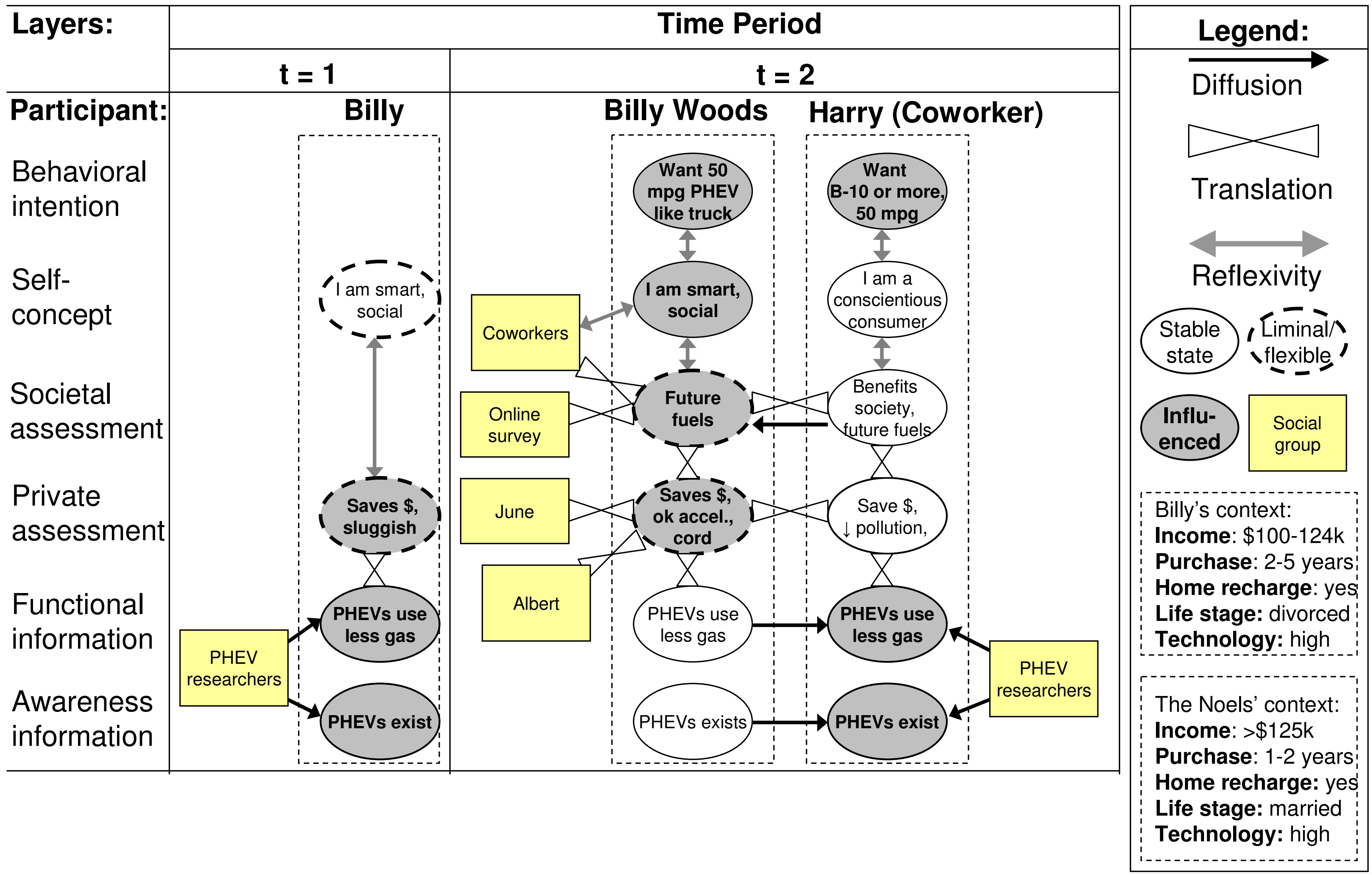
The Noels also diffused information about the PHEV to some alters, including Rupert Noels' manager, John, who served as secondary participant. From Rupert, John learned that PHEVs exist and could reduce gas spending (though researchers had to further clarify some confusion regarding these concepts), and, contrary to his initial perceptions, that electric-drive vehicles could have powerful acceleration. John indirectly translated this information to inform his private assessment of the PHEV, though his societal assessment of electric-drive remained unchanged. His private and societal assessments are reflexively linked with his stable self-concept of being a smart consumer, as well as his intention to purchase a PHEV if it offers fuel economy he deems to be satisfactory.

Figure 39: The Noels' RLI framework



Billy Woods' PHEV experience is depicted using the RLI framework in Figure 40. Similar to the Noels, Billy's initial assessment was informed by researchers' explanation of the technology. However, Billy's self-concept was in a liminal state—he viewed himself as a smart, social, active person, but at that time open to exploring new ways of living and defining himself. By the end of his PHEV trial, Billy's private assessment was informed through direct and indirect translation with friends like Albert, and by exploring the PHEV with June. Billy also became interested in the societal aspects of the vehicle through the online survey, which he further explored by polling some of his coworkers. Through direct translation, Billy integrated his coworker's responses into his own societal assessment by decreasing the importance of environmental issues. Further, this interaction is an example of direct reflexivity, as the question of emphasizing private versus societal benefits helped Billy to further stabilize his own self-concept—he became more confident in viewing himself as a smart consumer rather than an environmentally-motivated one.

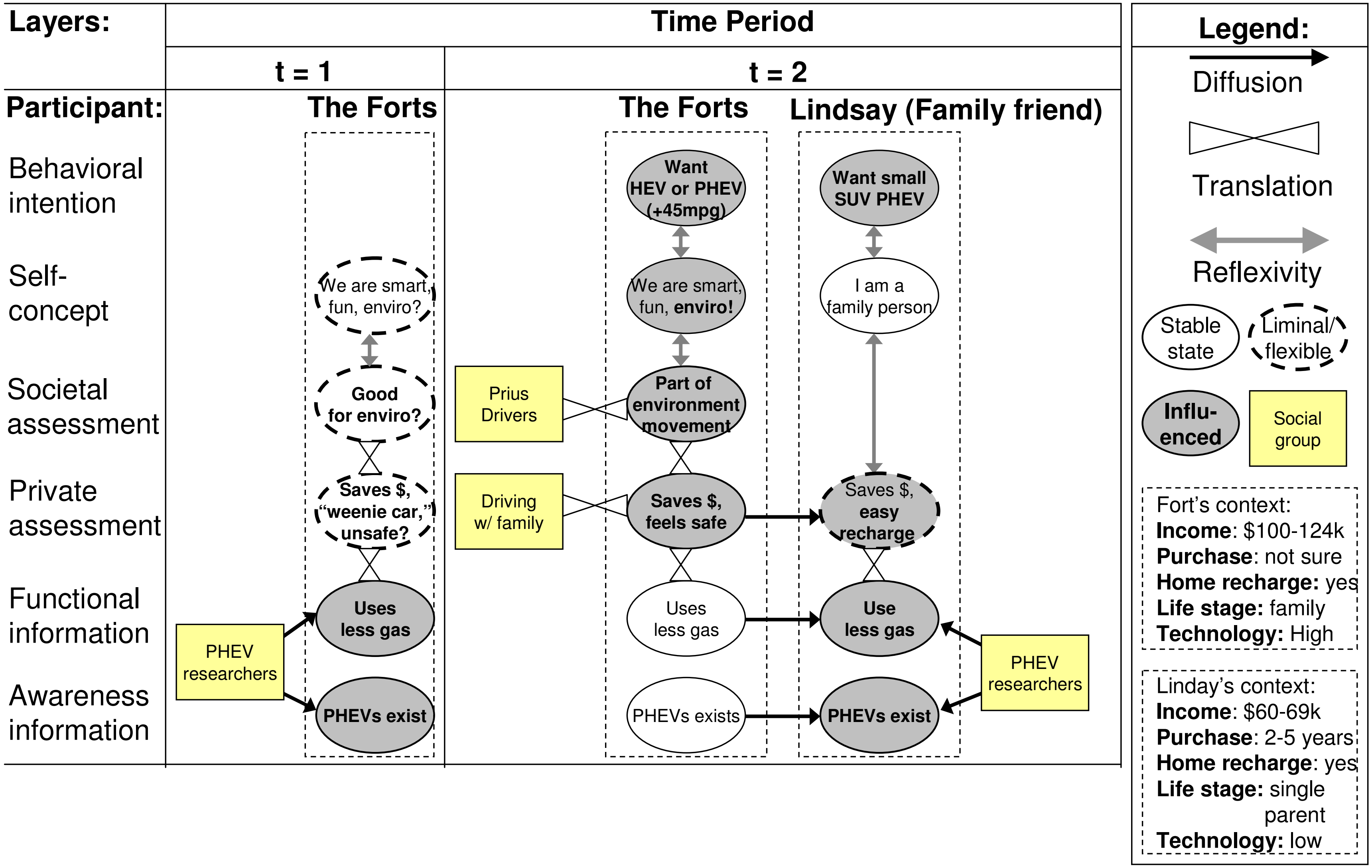
Figure 40: Billy Woods' RLI framework



Billy also interacted with Harry, who served as a secondary participant. Billy diffused basic awareness and functional information to Harry (both by parking next to him and talking to him on the phone). Harry (indirectly) translated this information into a societal assessment of the PHEV as a technology with wider market appeal than Harry's limited range EV—offering broader pro-societal benefits. In turn, Harry diffused information about his own EV to Billy, some of which Billy translated (indirectly) into his societal interpretation of the PHEV as linked to the future development of alternative fuels, like hydrogen. In the end, neither actor directly influenced the others' self-concept or purchase intention, but they did indirectly influence one another's assessment.

Figure 41 depicts the Fort's PHEV experience. After learning about the PHEV from researchers, the Forts were initially unsure if such a car could save them money, would be perceived by others as a "weenie car" and was safe enough for them to drive regularly (flexible private interpretations). They were also unsure if the PHEV had environmental benefits (flexible societal interpretations) that would link to their recent experimentation with environmental lifestyle practices (lifestyle liminality). By the end of their trial, after driving the PHEV as a family and receiving pro-societal support in their social network, the Forts reduced their private concerns of safety and image and solidified their commitment to environmental values.

Figure 41: The Forts' RLI framework



The Forts also diffused functional and assessment information to alters like Lindsey. Lindsey learned functional information about the PHEV from Selena Fort, such as how it achieved impressive fuel economy and was easy to recharge. Lindsey linked these benefits to her stable self-concept of being a family-oriented single parent who was concerned about saving money and making smart financial decisions. In this social interaction, influence was unidirectional; Lindsey did not exert any social influence on the Forts' assessment of the PHEV (as reported by the Forts).

These examples illuminate the important, though typically indirect, roles that diffusion, translation and reflexivity can play in PHEV assessment, self-concept, purchase intention and ultimately, though not observable here, purchase behavior. The RLI framework accounts for heterogeneity among instances of social influence: information and interactions can range from simple to highly complex, the flow can be one-way or multidirectional, and the process can directly or indirectly impact awareness, functional understanding, assessment, self-concept, behavioral intention and/or purchase behavior. In these examples, direct influence is observed at layers of awareness, functional understanding, private and societal assessment and self-concept. Further, although not observable in this study, an individual's intention or purchase could also directly or indirectly influence another individual at various layers.

7.4 Generating hypotheses from the RLI framework

Because this dissertation followed a qualitative research approach, I explored several general research questions rather than formulating specific hypotheses from the start. However, hypotheses generation can be one outcome of the qualitative research process. Here I formulate several hypotheses that can be further explored in future research. Each is informed by the previous literature, empirical observation and proposed RLI framework as presented throughout this dissertation. In particular, I use terminology from the RLI framework to articulate the hypotheses, as follows:

1. An actor's self-concept can change, including their valuation of private versus pro-societal benefits.
2. Actors with a primarily private self-concept are more likely to value the pro-societal benefits of a new artifact if the actor:
    a. has a basic functional understanding of the artifact,
    b. is in a state of lifestyle liminality, and/or
    c. finds support for pro-societal values among their relevant social system.
3. Processes of direct translation are more likely to influence adoption behavior than processes of diffusion and/or indirect translation.
4. In a given social interaction, direct translation is more likely to occur for the actor than diffusion or indirect translation if:
    a. the alter is socially close,
    b. the alter has previous experience with the artifact,

c. the interaction takes place over multiple social episodes, and/or
d. information exchange and/or influence are multidirectional.

5. Direct reflexivity occurs less frequently than other forms of social influence, but when it does occur, it is more likely to influence the actors' vehicle assessment and purchase behavior.

7.5 Assessing the RLI framework

To an extent, the RLI framework accounts for each of the components Jackson (2005, p.x) highlights as integral for a "useful model," including: "motivations, attitudes and values; contextual or situational factors; social influence; personal capabilities; and habits." The basis of an actor's motivations stems from their self-concept and project of the self—their desire to construct a meaningful narrative from their life experiences that represents who they are and where they are going. This self-concept is reflexively linked to how the actor frames their attitudes towards the purchase and use of a new artifact, as well as other potential lifestyle practices they may or may not adopt. Included is how the actor considers and prioritizes private and societal benefits of the artifacts. Social influence is represented as a multitude of processes that help the actor to learn about the artifact and its functions, assess how it benefits them and society, test out different lifestyle practices, and develop their own self-concept. Assessment and intention are implemented into action only when aligned with contextual factors, such as market availability, pricing and government support, and personal capabilities, such as household income and access to the artifact. Finally, habit is represented as a tendency towards the status quo—the actor tends to engage in practices that align with self-concept. If self-concept is stable, practices established as well-aligned with this concept may become relatively automatic. However, if an individual enters a state of lifestyle liminality, they may start to break old habits and consciously experiment with new practices as trials of a new lifestyle.

The primary contribution of the RLI framework is the orientation and structuring of important concepts from different research perspectives into a single model. Here I have applied RLI to qualitative research in a descriptive manner. RLI could also be used to guide quantitative research, and could feasibly be helpful in predictive applications. For instance, the hypotheses articulated in the previous section could be operationalized and tested with statistical models in a large-scale, representative sample of car buyers.
Of course, the intention of RLI is not to necessarily develop a framework of structural equations or other quantitative set of relationships. RLI is valid as a framework to guide the design of qualitative research projects and the construction of participant narratives. In fact, I hope that RLI will inspire social influence and transportation behavior researchers—two disciplines mired in the positivist paradigm—to more actively consider the use of the qualitative research approach and instruments.

8 Conclusions

8.1 Some research answers

This dissertation set out to explore three research questions relating to social influence and vehicle adoption behavior using a qualitative, multi-method research approach. Within the context of the North Californian car buyers' that participated in a plug-in hybrid-electric vehicle (PHEV) trial, the results provide answers for each question.

8.1.1 #1: Social influence does matter

The first question relates to "proof of existence"—do social interactions influence PHEV assessment? The question explores if social influence is worth researching in the context of vehicle purchase in general, and PHEV assessment in particular, and if the employed methodology can effectively observe such influence. Results clearly indicate that yes, social influence does matter, and in most cases car buyers' are conscious enough of these processes to report them via the employed research instruments. Of the 10 primary households, nine identify at least one social interaction as being moderately influential over their assessment of the PHEV, while seven identify at least one social interaction as being highly influential. The one household that did not identify any influential social interactions explained that in previous contexts, social interactions had influenced their own vehicle purchase decisions and those of their friends. However, because they and their friends did not perceive the PHEV as substantially novel related to their own hybrid vehicles (and perhaps compared to their expectations of PHEVs), their PHEV trial did not generate much excitement or social interaction. Including this last households' explanation (made possible by the qualitative, open-ended portion of the research design), all households yield evidence that social interactions do play an important role in vehicle purchase behavior. Further investigation of the observed social interactions suggests that a given interaction between the primary household and a given alter tends to be rated as more influential by the primary household when: pro-societal aspects of the PHEV are discussed, the alter has more functional understanding of electric-drive technology than the primary, and the primary and alter are socially closer to one another.

8.1.2 #2: Social influence is driven by diffusion, translation and reflexivity

A literature review of interpersonal influence and consumer behavior highlights five research perspectives on social influence. *Contagion* emphasizes the importance of the unidirectional flow of information, as in diffusion of innovations (DOI) (e.g. Rogers, 2003). *Conformity* accounts for how an individual is influenced by their perceptions of what others around them are doing or expecting (e.g. Granovetter, 1978). *Dissemination* describes how groups of resourceful, pro-societal individuals can coordinate to intentionally diffuse positive information about a pro-societal product or technology—known as a critical mass (e.g. Oliver, et al., 1985). *Translation* represents how social groups can negotiate different interpretations of a new technology, eventually reaching a state of agreement and influencing the development of the technology in the process (e.g. Law and Hassard, 1999; Pinch and Bijker, 1984). Lastly, *reflexivity* describes how individuals work to arrange their various lifestyle practices, such as the purchase and operation of a vehicle, into a meaningful trajectory that effectively communicates their self-concept, which is itself mediated and negotiated through of such practices (Giddens, 1991).

Participant narratives were analyzed according to these five perspectives on social influence. Contagion, conformity, and dissemination are found to provide useful concepts for particular processes, but translation and reflexivity 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, e.g. the critical mass. In contrast, translation and reflexivity acknowledge the ongoing negotiations and development of interpretations, values, and lifestyle practices associated with evaluating an innovation. However, the notion of diffusion (categorized within the contagion perspective) is useful for describing and exploring the flow of simple, functional information relating to the PHEV—which proves to be an important foundational process in PHEV assessment. Thus, I conclude that processes of social influence are best characterized using concepts from three complementary perspectives: diffusion, translation, and reflexivity.

8.1.3 #3: Pro-societal values can be developed, subject to three conditions

I observed that four of the 10 primary household used their PHEV trial to actively experiment with pro-societal values ("pro-societal explorers"). Two of these households concluded their PHEV trial with primarily private values (where they started), while the other two concluded with relatively stable pro-societal values—as measured by increased pro-societal behavioral commitments (a significant shift from where they started). Through narrative analysis, I identify conditions that explain why some households consider pro-societal values, and of those that do, why some commit to pro-societal values while others do not. I identify three conditions—in the context of this PHEV trial, it appears that each condition is necessary (but not sufficient) for an initially privately-motivated household to shift towards pro-societal values and lifestyle practices.

First, if the household is not already engaged in a pro-societal lifestyle, their lifestyle must be *liminal* enough to permit them to consider alternatives to their current private lifestyle—that is, their self-concept must be in a relatively flexible and/or transitional state. In some cases, liminality is a temporary state of transition, as with a shock to the household such as a divorce, which eventually returns to a more solidified state. In other cases, liminality can be sustained, such as when a household's children grow up and move out, as the disposable income increases, or by the nature of an insular social network structure. Although liminality seems necessary for a household that previously valued vehicles only for their private values to consider pro-societal values, liminality does not need to be sustained after a pro-societal transition takes place.

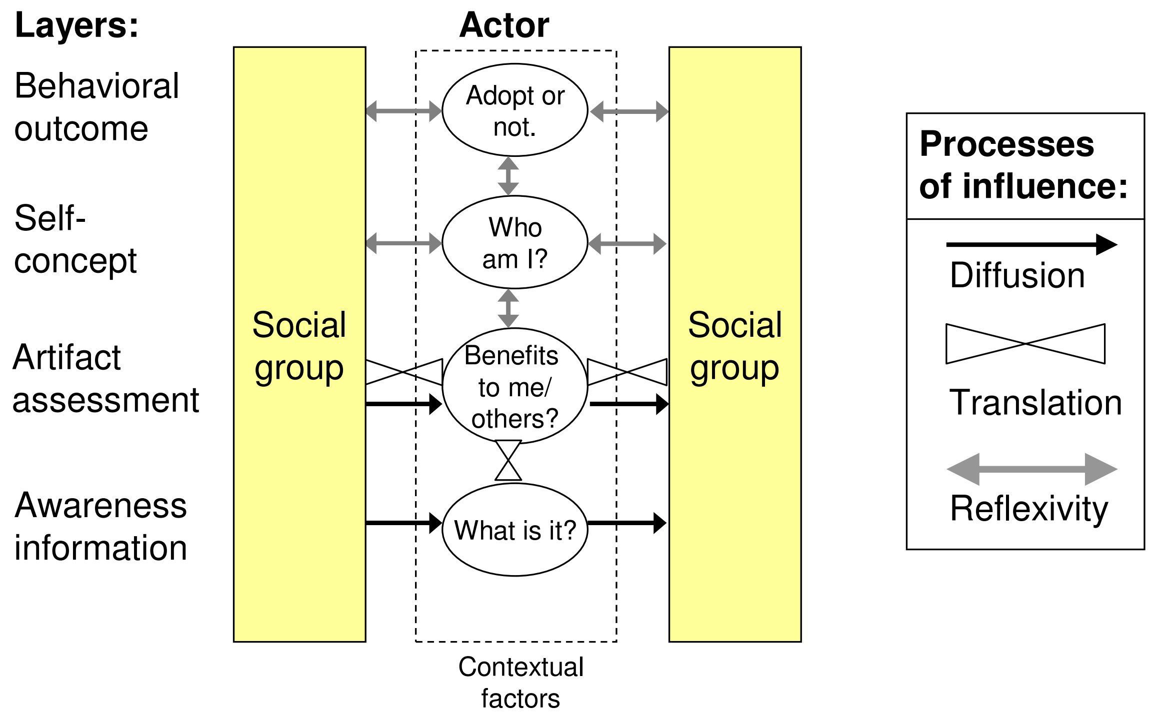
The second condition is a basic functional understanding of the PHEV technology. The household does not need prior experience or familiarity with electric-drive technology, nor do they need to be electric-drive experts or enthusiasts. However, an individual or household must at least understand what a technology does before they can consider who it is good for, that is, before they can frame its benefits according to private versus societal impacts. Thus, households are more likely to form stable assessments of pro-societal benefits if they can easily grasp the most basic functions of the PHEV, e.g. that plugging it in can offset gasoline use by using electricity. Having a technical background can facilitate such quick learning. Households that did not quickly learn the basic functions of a PHEV did not end up considering pro-societal values during their PHEV trial.

The third identified condition is a demonstrated support of pro-societal values within the social network. Among the households that explored pro-societal values, the presence or absence of such support is associated with their final interpretation of the PHEV. The two households concluding their PHEV trial with private interpretations described a lack of pro-societal support in most or all key areas of their social network. In contrast, the two households that concluded with pro-societal interpretations of the PHEV perceived social support among alters they considered to be particularly influential. Further, the households that did not consider pro-societal values at all did not perceive significant support for pro-societal values anywhere within their social networks.

8.1.4 Reflexive layers of influence (RLI): An integrated perspective

As a final stage to this research, I propose a framework to integrate the various processes of social influence observed in this study—what I call reflexive layers of influence (RLI). RLI represents four basic layers that lay beneath the "surface" of the observed vehicle purchase (Figure 42). Building up from the bottom, layers include: functional awareness, assessment of the artifact (private and societal), self-concept, and behavioral outcome, e.g. vehicle purchase. Social influence can impact lower layers through the diffusion of simple information, such as awareness of the artifact in question. Social influence can impact the private and societal assessment layers through translation, where the car buyer develops particular interpretations of the artifact's benefits relating to their own interests and self-concept. These assessments are reflexively linked to that actor's self-concept, which can both serve to frame their assessment, but can also be reinforced or altered according to that assessment. This self-concept is also reflexively linked to the apparent lifestyle practices of other actors, as well as the observed actor's purchase intention and eventual adoption (or non-adoption) behavior. All layers are also constrained by contextual factors, such as car buyers' life stage, disposable income, need for a new artifact, as well as the market availability of the artifact, price, marketing efforts and government support. When the actor's assessment of the artifact aligns with their self-concept and favorable contextual factors, they are more likely to create a purchase intention and fulfill it by adopting the artifact.

Figure 42: The basic RLI framework



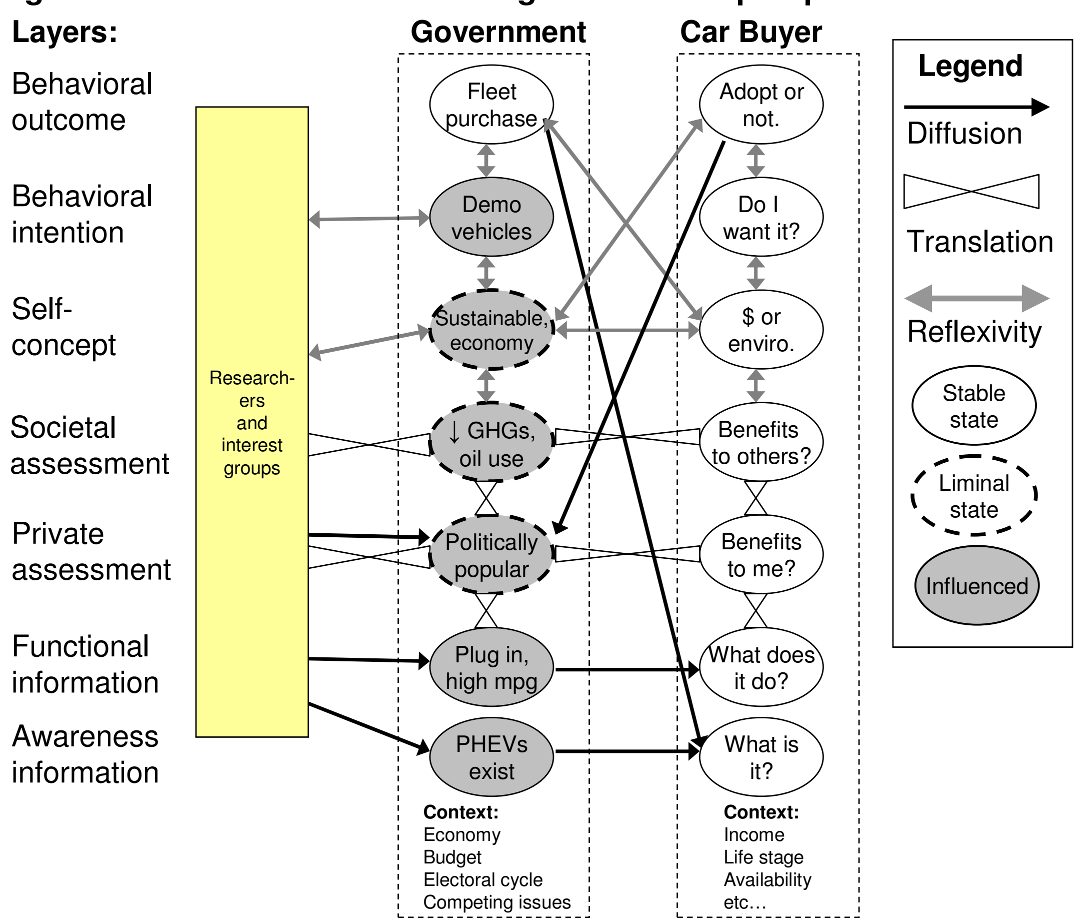
8.2 Policy implications of RLI

Jackson (2005) explains that the rational choice behavioral perspective (the dominant perspective in transportation research) suggests only two levers for policymakers to influence consumers regarding a particular artifact: 1) changing the price and 2) providing information. Similarly, the diffusion of innovations (DOI) perspective (the dominant perspective in social influence research) asserts that the unidirectional flow of functional information is the primary means of social influence. DOI assumes a small, fixed proportion of consumers are visionary innovators or early adopters that might consider non-functional attributes of the technology, e.g. societal benefits, and all other buyers are motivated only by private, financial benefits. By implication, policymakers might disseminate information to these innovative buyers to start the diffusion process, but the price of the product will eventually have to be lowered to achieve mass market success.

The goal of this dissertation is to move beyond such simplistic behavioral models, exploring a multitude of complex processes that influence human behavior. Here I offer initial suggestions for policy implications, though further research should explore these ideas further. A primary insight is that social influence can be a very powerful lever: households can actually alter their values, such as shifting towards pro-societal concerns, under certain social and contextual conditions. Further, not all processes of social influence are equal, and not all interactions between actors are influential. To design policy that can successfully influence behavior, policymakers need to carefully consider how different types of information and interactions can influence the various factors relating to a car buyers' purchase decision. In Chapter 7, I propose the RLI framework to help conceptualize the different processes of social influence, and apply it to several households that participated in this study. Here I extend RLI to illustrate how it could help guide policymakers.

As an illustration, Figure 43 applies RLI to processes of influence that can occur between interest groups, government policymakers and car buyers. Researchers, electric-drive enthusiasts, environmental advocates and other interest groups might influence policymakers in a variety of ways at different RLI layers. Interest groups might diffuse awareness information or translate research findings about the political popularity of PHEVs (private benefits to the policymakers) or the GHG or energy impacts of PHEVs (benefits to society). Interest groups may also reflexively influence policymaker goals (self-concept) regarding sustainability, and suggest particular actions like procuring a fleet of PHEVs to demonstrate the technology. The actions and interests of policymakers can also reflexively impact research groups. The actions of government policymakers can also influence car buyers through similar processes: diffusion of awareness and functional information, translation of private and societal interpretations and assessments of the artifact, and reflexive considerations of values and self-concepts. Further, the actual adoption of PHEVs by government or car buyers can help diffuse awareness of the technology, or reflexively influence the other actor's self-concept.

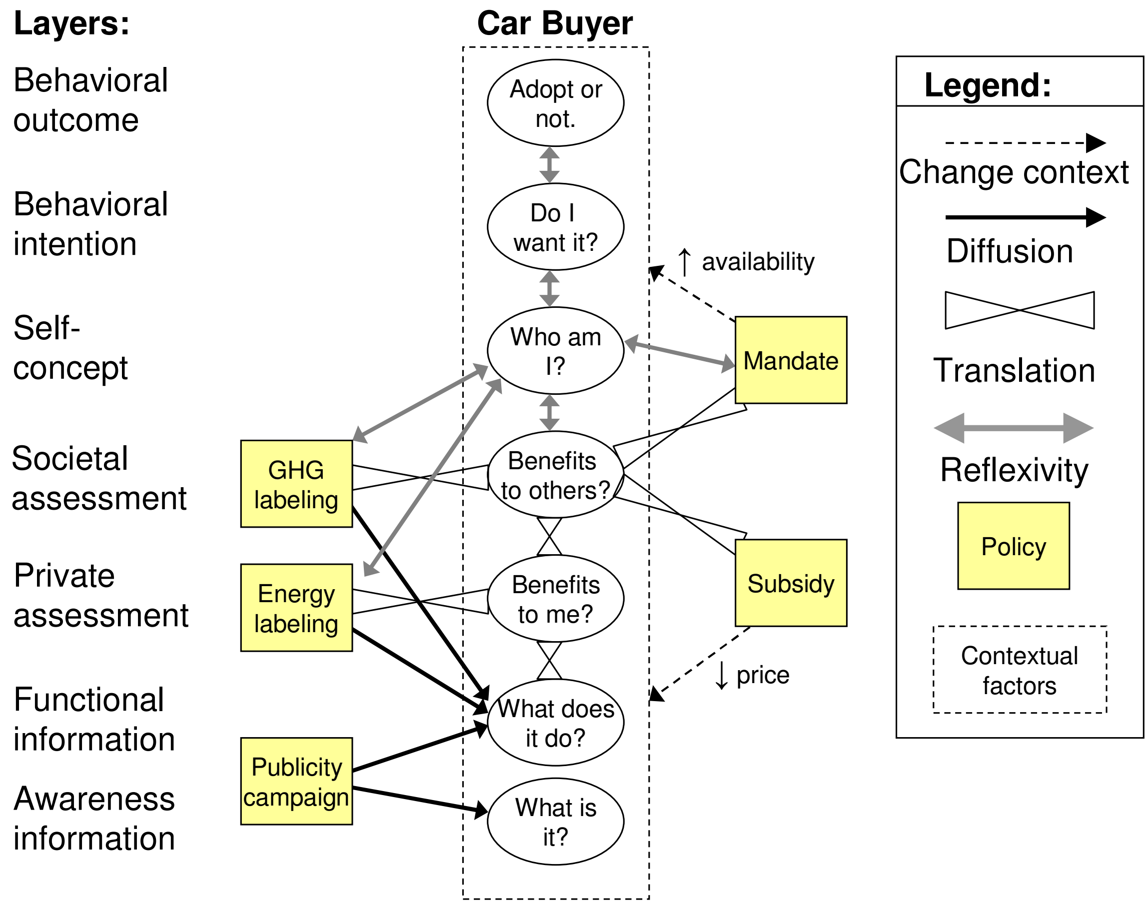
Figure 43: Social influence from a government's perspective



For example, consider the case of policymakers attempting to achieve societal goals by intentionally diffusing, or disseminating, information about PHEVs. Information may include awareness of the technology's existence, functional information about what it does (using electricity to offset gasoline), and interpretations of how it may benefit an individual through cost savings or benefit society through reduced environmental impacts. Figure 44 depicts how specific policies might influence a car buyer. A policymaker might disseminate information through labeling standards, publicity campaigns, or energy information websites. Policy-driven dissemination may be particularly important in regards to awareness information and functional understanding—I have shown that these layers are an essential foundation typically required for the car buyer to form a stable assessment of the technology and reflexively integrate it with their self-concept.

However, other than laying this foundation, diffusion itself is not likely to have a significant impact on the car buyers' assessment, self-concept, intention or adoption. For example, several participants in this study were aware of General Motor's (GM's) forthcoming PHEV model, the Chevy Volt. However, most of these participants had little idea of what the Volt could actually do, such as if it used gasoline, grid electricity, both, or some other fuel(s), and could not articulate its benefits other than being a novel technology. Thus, these participants could not form stable positive or societal assessments of the technology. So, while awareness information of the Volt had been successfully diffused to these participants, this information had not been effectively translated by the GM (direct), or by participants (indirect).

Figure 44: Policy levers for social influence



In contrast to diffusion, translation describes a more sophisticated form of social influence that impacts the actor's assessment of the technology. Through translation, the actor develops a more refined understanding of the technology, how it might benefit them personally, if it might benefit society, and (through reflexivity) if they should care if it benefits society. As an example, translation might occur through a labeling program. If labels on new vehicles clearly depict fuel economy and anticipated fuel savings or losses (say, relative to an average vehicle), the label is not only serving to disseminate functional information about the vehicle, through translations it may also help to frame a car buyer's private assessment in terms of financial savings. In contrast, a GHG emissions label could translate to the car buyers' societal assessment of the vehicle as a way to reduce environmental impact, or even reflexively stimulate a reconsideration of self-concept. However, as I hypothesis in Section 7.4, influential processes of translation and reflexivity may be more likely to occur in particular types of interpersonal interaction such as with socially close alters, through person-to-person, multidirectional interactions that permit dialogue with familiar individuals. Of course, direct translation is resource-intensive and thus more of a challenge for policymakers.

A real-world example of direct translation might be an energy-audit program, where qualified representatives visit a household, assess their energy use, and produce customized recommendations of how the household could change their energy use and how it might benefit them and society. Because the audit is personal, the provided information is more easily translated by the actor according to their own self-concept. Such an approach is costly for widespread implementation, and in some cases might more closely approximate diffusion than translation—the actor does not have an established relationship with the auditor and may not be motivated to seriously consider their recommendations. Relating to PHEVs, a similar example might be the present study; researchers visited participants in their homes, engaged in an ongoing dialogue about electric-drive vehicles, and helped participants to assess if such a technology might fit into their household. Researchers intentionally tried not to influence the participant's PHEV assessment, but they inevitably translated information for participants and were typically described by participants as having influence over their PHEV assessment.

While such interventions widely enacted might be cost-prohibitive for policymaker consideration, translation can occur through more subtle methods. Understanding how ifferent policies and types of information can influence the different RLI layers can help policymakers to better design policy, predict its effects, and measure its impacts (Thaler and Sunstein, 2003). For example, consider the vehicle labeling example, where the focus of the label (cost savings or GHG savings) could frame car buyers' interpretations. Further, as summarized in Section 1.4.3, Green (1992) also asserts that governments are powerful social groups, and the framing of policy can influence consumer interpretations and values. Green's example is California's zero-emissions vehicle (ZEV) mandate (Figure 44), which initially implied that consumer behavior would have to change (to start purchasing ZEVs) to benefit society (by reducing harmful emissions). In other words, a policy designed to set production constraints on manufacturers can also contribute to a cultural dialogue of whether consumers should be motivated by private or pro-societal benefits. Green laments that the ZEV mandate was later reworded to emphasize the importance of consumers' rights to enjoy the private values of consumer comfort and financial concerns, thus losing the potential for consumers and social groups to translate the policy into a pro-societal message.

The implication of Green's argument is that any policy can influence consumers at multiple layers of the RLI framework, even if unintentionally. For instance, consider a subsidy or tax break offered to PHEV buyers (Figure 44). The subsidy reduces the perceived price of attaining the vehicle, a contextual factor. At the same time, diffusion of information about the subsidy may carry awareness and functional information with it—an actor may be unaware that a PHEV exists or unsure of what it is until they hear about the subsidy for it. The subsidy could directly translate to the actor's private assessment of the PHEV, increasing the potential to save money. Further, the actor may translate the subsidy to inform other aspects of their private and societal assessment. They may try to interpret why the government is offering this subsidy, perhaps because: the technology is unreliable and needs government help; the government helps consumers to support the environment; society thinks consumers should only worry about cost savings; or the government is wasting tax dollars. In other words, policymakers need to consider the variety of plausible processes of influence flowing from a given policy, and RLI provides a useful framework to do so.

8.3 Assessing qualitative and quantitative research methods

To investigate the role of social influence in vehicle buyers' assessment of plug-in hybrid electric vehicles (PHEVs), I implemented a research design that utilized several research instruments. My intention was to effectively observe processes of social influence by mapping out a participant's social network, providing them with a PHEV for a multi-week trial, and then asking them to report any social interactions pertaining to the PHEV. Further, I followed a qualitative research approach—focusing primarily on semi-directed interviews—to allow participants to report and explain their experiences of social influence in their own words rather than constrain their responses to fit within pre-determined categories corresponding with a particular theory or perspective. Overall, I believe this methodology achieved both objectives: in-depth information was collected regarding a wide variety of social interactions, and participants were generally able to articulate such experiences using their own language.

The research design employed in this dissertation allows an interesting comparison between quantitative and qualitative research approaches, instruments and analysis. I integrated quantitative instruments, such as the online questionnaire, sociogram construction exercise and influence ranking exercises, with qualitative instruments—the semi-directed interviews. At some points, both quantitative and qualitative data were being collected concurrently, such as when participants ranked the influence of social interactions on a numeric scale while verbally explaining their reasoning behind their ranking. Such integration proved useful in exploiting the strengths of different research approaches: semi-directed interviews allowed participants to report experiences in their own words, while quantitative instruments provided structure to help participants and researchers work through ambiguous tasks, such as characterizing a social network, or comparing the influence of different experiences.

I also employed quantitative and qualitative forms of analysis. Chapter 4 provides a quantitative summary of participant and social network characteristics, social interactions and ranking of social influence. A logistic regression analysis was conducted as one quantitative tool to help assess why some social interactions were ranked by participants as more influential over their PHEV assessments than other interaction. In contrast, Chapters 5 and 6 explored processes of social influence using more in-depth, qualitative data—that is, narratives constructed from the semi-directed interviews. While both analyses yielded interesting insights, the qualitative analysis proved most effective for this dissertation's research objectives. Quantitative analysis only proved useful for exploring the first research question (does social influence matter?), and although the logistic regression helped tease out aspects of the second question (characterizing processes of social influence), it only identified a few important factors. In contrast, narrative analysis was essential to fully explore the second question by "trying on" each of the five perspectives on social influence and applying to participant narratives, and likewise to further explore these narratives to answer the third question (condition for pro-societal exploration).

In this sense, the main finding of this research could have been conducted without the logistic regression analysis (though it might not have been as successful without the quantitative instruments). The main use of the logistic regression analysis was to help me, the researcher, to sort through the various, potentially confounding ideas I identified through qualitative analysis. For instance, in constructing and comparing participant narratives, I developed a sense that there was something important about social interactions with pro-societal content—though I had trouble discerning how prevalent and strong this affect was relative to other factors. The logistic regression was one tool to help me sort through the 275 reported social interactions, and find that pro-societal content was indeed important across observations when controlling for social proximity, mode of interaction, pro-environmental attitudes and experience with electric-drive. This tool helped transform my general suspicion into a more confident finding. However, without the narrative analysis, the logistic regression on its own would miss most of the important details of context that surround each participant's experience—particularly those factors that are not easily quantified or coded. So, in the context of the research questions explored in this dissertation, I view the regression as just one potential tool to help researchers identify relationships among variables, rather than being an end in itself. In contrast, the narrative analysis proved immensely useful in exploring several research questions, and identifying unexpected relationships and patterns.

8.4 Directions for future research

The inquiries explored in this dissertation are by no means complete. In attempting to answer the three main research questions, many unanswered research questions have arisen. For instance, Section 7.4 articulates several hypotheses that can be further tested in future research. Here I more broadly suggest several potential directions for consumer research relating to social influence, pro-societal values and vehicle purchase behavior. The ordering of these potential projects reflects my own prioritization according to importance, beginning with what I see as the most promising research projects.

8.4.1 Ethnographic focus groups: Direct observation of social influence

A limitation of the present methodology is reliance on retrospective recall of social interactions rather than directly observing them. While retrospective recall has the benefits of practicality and less invasiveness, direct observation may yield unique insights. One idea is to implement an ethnographic focus group methodology, bringing together several socially connected individuals for one or more multi-hour interviews. To create a more natural and relaxed setting, the focus group could take place at a location where the participants normally meet, such as one of the participants' homes, a coffee shop or restaurant. Researchers would prompt the participants with general questions about the technology or behavior in question. This method could be used to further explore how technology controversies are negotiated in a social group, using a framework similar to the social construction of technology (SCOT) (e.g. Pinch and Bijker, 1984). Relating to PHEV technology, the group could be prompted to discuss contentious interpretations identified in the present study, such as: the durability of battery technology; the toxicity and environmental impacts of battery technology, whether buying and operating a PHEV saves money; if electricity is better for individuals or society than gasoline; and whether a buyer should be motivated by private or societal concerns. In addition to directly observing interactions and negotiations among participants in a relatively natural social setting, researchers could also ask participants to explain the roles of sources of information not explored in this dissertation, such as media, advertising and government messages and policy.

8.4.2 Large-scale online survey

Another important direction for future research is to further explore these research questions and the specific hypotheses posed in Section 7.4 using a quantitative approach, such as a large-scale online survey of U.S. new car buyers. The survey might use a combination of open-ended and closed-ended questions to elicit information about the respondent's previous vehicle purchases, such as what sources of information they consulted prior to making the purchase (friends, family, coworkers, acquaintances, magazines, websites, etc.) and how influential each source was in relation to their final purchase. The survey could also operationalize and measure the relationships between factors hypothesized by this study, such as how the characterization (or non-existence) and stability of a respondent's societal self-concept relates to their lifestyle liminality, their perception of pro-societal support within their social network, and technical background. Further, such patterns could be related to the assessment of PHEV technology, and measured over time. As different PHEV models become commercialized over the coming years, more information about the technology will become available in the market. A longitudinal survey could ask the respondent to log in once a month for several months or a year, each time indicating what they have learned about PHEVs, and how their assessment of the technology has changed. The respondent could complete a "PHEV learning diary," which includes any details they learn from the media, advertising, websites, social interactions or other sources, which improves their recall for survey questions each month.

8.4.3 Measuring pro-societal values as lifestyle practices

Results from this study also hold important implications for the study of pro-societal values. Because pro-societal values, self-concepts, and lifestyle practices are dynamic, classifying individuals as pro-societal based on their responses to attitudinal questions (as is conventionally done) may be inappropriate, unreliable and generally inaccurate. For instance, Stern et al. (1999) utilize the new environmental paradigm (NEP) as a measure of pro-environmental values, where respondents' NEP score is based on their stated agreement or disagreement with several statements, such as "humans have the right to modify the natural environment," and "humans must live in harmony with nature in order to survive." In contrast, I classify participants into three categories of motivation—private, pro-societal and exploring pro-societal values—based not just on what they say about their attitudes but also on what they do. Researchers repeatedly visited primary households, conducted five to seven hours of interviews per household, and collected information about their social episodes, social networks, driving and recharge behavior and societal attitudes. Though prolonged, in-depth contact I became familiar with each household on several dimensions, including their commitment to societal issues. I discovered that the household's response to a survey question, such as their opinion on the importance of global warming, is not a reliable indicator of their commitment to pro-societal values. A more accurate, useful and reliable measure is what the household actually does—that is, how much time and effort they devote to pro-societal practices. Even if a household has positive environmental attitudes, if they are not devoting any time towards pro-environmental practices, they are not subscribing to a pro-societal lifestyle. However, if they regularly recycle, reduce water use, buy energy efficient appliances, drive efficiently, carpool, use transit or cycle on a regular basis for environmental purposes, they are demonstrating a commitment to pro-societal values.

While it is easy for a respondent to falsely portray a socially-desirable attitude on a one-shot survey, it is more difficult to keep up a pretense over time (as with the repeated interactions of this study) or when eliciting details about particular actions. In short, I suggest that measures of pro-societal values should be aligned with Giddens' (1991) notion of lifestyle practices: does the household devote time and other resources to pro-societal practices on a regular basis, and interpret these practices as part of a pro-societal lifestyle trajectory? At the same time, categorization of pro-societal values should allow for dynamics, as also indicated by Giddens' description of reflexivity. Such measures of pro-societal commitment could be further explored in qualitative interview and focus group settings. Researchers might explore the respondent's life history in terms of environmental awareness, concern and practices up to present day, and their planned trajectory for future practices. In quantitative applications, respondents might be asked to list a number of practices they consider to be pro-societal (or select them from a provided list) and report how much time in the last month they devoted to each practice. The dynamics of pro-societal commitment might be more difficult to measure in a survey setting, but could possibly be explored with a longitudinal design.

8.4.4 Mapping symbolism

Another limitation of this dissertation is the focus on social interactions as the primary unit of social influence. However, as noted in research perspectives such as conformity and as described by some research participants, social influence can occur through the actor's perceptions of what others are doing, thinking, or what they expect or value. Such information may not be communicated in a particular social interaction, and thus is neglected in the present study. This omission particularly limits the understanding of how social influence relates to symbolic interpretations. Although Heffner et al. (2007) find compelling evidence of the importance of symbolic values within the early HEV market, social interactions observed in the present study typically do not directly address symbolic PHEV benefits and I found no statistical relationship between symbolic content and an interaction's rated influence. I conclude that my present research design is not well-suited for observing symbolic value. Future research could explore the integration of research instruments from this study and that of Heffner et al. For instance, in the sociogram mapping stage, I might add an exercise asking participants how they anticipate each alter or social group in their social network might perceive their PHEV on functional and symbolic dimensions. The participant could update these perceptions as their PHEV trial proceeds. The sociogram may then become not just a map of the participant's alters, but also a dynamic map of the developing symbolic value of the PHEV among different social audiences. This inclusion may prompt the participant to include symbolic considerations in their narrative responses.

8.4.5 Constructing life and vehicle ownership trajectory

Insights from this study could also be used in the study of a household's vehicle purchase behavior. In Section 7.2.3, Figure 34 depicts a timeline of several contextual factors that could influence a household's vehicle purchases over their lifetime. A similar visual could be constructed by a car buyer, where they identify and plot several important factors over their vehicle purchase history, including their disposable income, life stages, commitment to different values or interests, awareness and understanding of different vehicles, and other key events such as car accidents, and how all of this relates to their vehicle purchases decision and timing. This exercise could help the participant to illustrate their narrative of previous vehicle purchases, and how they got to the present. A final stage of the exercise could guide the participant through a future trajectory of these factors, indicating where they see their life going, and what vehicles they may purchase as part of that, and when. The entire process might make it easier for the participant to verbally and visually summarize their vehicle purchase history and planned trajectory, while perhaps more accurately considering the various contextual factors that guide their previous and future purchases.

8.4.6 Observing total network effects

Another direction for social influence research may be to widen the scope of beyond the personal network. The present study only observed social interactions within one degree of separation from the primary household, that is, within their personal network of alters. However, diffusion, translation and reflexivity also occur beyond this border, and may follow different patterns at a wider scale. This might be explored through the observation of a total network that is somehow bounded and more narrowly defined than networks based on social proximity (as used in the present study). For instance, I might focus on a total network of coworkers at a workplace, where a large proportion of coworkers can be recruited into the study, and researchers are permitted to map the social connections among all of these coworkers—thus mapping out a total network. Researchers could then stimulate the network, say by having some coworkers participate in a PHEV trial, then observe the interactions that take place not only between the trial participants and their alters, but also the subsequent interactions that take place between the alters' alters, and so on across multiple degrees of separation. Results might indicate how information and interactions processes might change as diffusion, translation and reflexivity move away from the originating source.

8.4.7 Observing actual vehicle purchase behavior

One clear observation from household narratives, and as represented in the RLI model, is that processes of vehicle assessment, purchase intention and eventual purchase are highly complex, and often involve a serendipitous alignment of factors internal and external to the car buyer. Sorting through these details is difficult, and was not fully accomplished in the present dissertation; I collected only sparse details about previous vehicle purchases, and could not observe actual PHEV purchases. A future study might utilize some of the research instruments developed in this dissertation to better observe actual purchase of vehicle. The sample would include households that anticipate purchasing a new vehicle within the next year. Researchers would then collect baseline information from the household as performed in this study, including vehicle purchase history, social network information, and basic vehicle and technology familiarity. Participants could then complete a diary of "vehicle research and discussion" over several months or a year, including all the sources of information about vehicles they encounter, and how they develop their assessment of different vehicle models over time. If a vehicle purchase occurs, participants would then be interviewed to explain the process in detail, including all the RLI layers of awareness knowledge, functional understanding, private and societal assessment, self-concept and purchase intention. Such a study would add a higher element of contextual realism to the PHEV trials and assessments observed in this dissertation.

9 References

Adamson, K. A., 2003. An examination of consumer demand in the secondary niche market for fuel cell vehicles in Europe. International Journal of Hydrogen Energy 28(7), 771-780.

Ajzen, I. and Fishbein, M., 1980. Understanding Attitudes and Predicting Social Behaviour. Prentice-Hall Inc., Englewood Cliffs, NJ

Anderman, M., 2008. PHEV: A step forward or a detour? . SAE 2008 Hybrid Vehicle Technologies Symposium, San Diego, California, February 12-14, 2008,

Arentze, T. and Timmermans, H., 2008. Social networks, social interactions, and activity-travel behavior: a framework for microsimulation. Environment and Planning B-Planning & Design 35(6), 1012-1027.

Asch, S. E., 1955. Opinions and social pressure. Scientific American 193(5), 31-35.

Atkinson, P. and Hammersley, M., 1994. Ethnography and Participant Observation. In: N. Denzin and Y. Lincoln (Eds.), Handbook of Qualitative Research, Sage Publications, Thousand Oaks,

Axhausen, K. W., 2005. Social Networks and Travel: Some Hypotheses. In: K. Donaghy (Eds.), Social Aspects of Sustainable Transport: Transatlantic Perspectives, Ashgate Publishing, Aldershot, 98-110.

Axhausen, K. W., 2008. Social networks, mobility biographies, and travel: survey challenges. Environment and Planning B: Planning and Design 35(6), 981-996.

Axsen, J., Burke, A. and Kurani, K. S., 2008. Batteries for plug-in hybrid electric vehicles (PHEVs): Goals and the state of technology circa 2008. University of California, UCD-ITS-RR-08-14.

Axsen, J. and Kurani, K. S., 2008. The Early U.S. Market for PHEVs: Anticipating Consumer Awareness, Recharge Potential, Design Priorities and Energy Impacts. University of California, UCD-ITS-RR-08-22.

Axsen, J. and Kurani, K. S., 2009. Early U.S. market for plug-In hybrid electric vehicles: Anticipating consumer recharge potential and design priorities. Transportation Research Record: Journal of the Transportation Research Board 2139, 64-72.

Axsen, J., Kurani, K. S. and Burke, A., 2010. Are batteries ready for plug-in hybrid buyers? Transport Policy 17(3), 173-182.

Axsen, J., Mountain, D. C. and Jaccard, M., 2009. Combining stated and revealed choice research to simulate the neighbor effect: The case of hybrid-electric vehicles. Resource and Energy Economics 31(3), 221-238.

Bandura, A., 2006. On integrating social cognitive and social diffusion theories. In: A. Singhal and J. Dearing (Eds.), Communication of Innovations: A Journey with Ev Rogers, SAGE, Thousand Oaks, CA, 111-135.

Bass, F. M., 1969. New product growth model for consumer durables. Management Science Series a-Theory 15(5), 215-227.

Bettman, J., Luce, M. and Payne, J., 1998. Constructive consumer choice processes. The Journal of Consumer Research 25(3), 187-217.

Blaut, J. M., 1987. Diffusionism - A uniformitarian critique. Annals of the Association of American Geographers 77(1), 30-47.

Blumer, H., 1969. Symbolic Interactionism -- Perspectives and Method. University of California Press, Berkeley, CA

Borgatti, S. P., Mehra, A., Brass, D. J. and Labianca, G., 2009. Network Analysis in the Social Sciences. Science 323(5916), 892-895.

Brown, M. B., 2001. The civic shaping of technology: California's electric vehicle program. Science Technology & Human Values 26(1), 56-81.

Brownstone, D., Bunch, D. S. and Train, K., 2000. Joint mixed logit models of stated and revealed preferences for alternative-fuel vehicles. Transportation Research Part B 34, 315-338.

Bruun, H. and Hukkinen, A., 2003. Crossing boundaries: An integrative framework for studying technological change. Social Studies of Science 33(1), 95-116.

Bunch, D. S., Bradley, M., Golob, T. F., Kitamura, R. and Occhiuzzo, G. P., 1993. Demand for clean-fuel vehicles in California: A discrete-choice stated preference pilot project. Transportation Research Part a-Policy and Practice 27(3), 237-253.

Burnett, R., 1991. Accounts and Narratives. In: B. Montgomery and S. Duck (Eds.), Studying Interpersonal Interaction, The Guildford Press, New York, 121-140.

Burt, R. S., 1997. A note on social capital and network content. Social Networks 19(4), 355-373.

CalCars, 2008. All About Plug-In Hybrids (PHEVs). <http://www.calcars.org/vehicles.html> April 17th.

Calef, D. and Goble, R., 2007. The allure of technology: How France and California promoted electric and hybrid vehicles to reduce urban air pollution. Policy Sciences 40(1), 1-34.

Calfee, J., 1985. Estimating the demand for electric automobiles using fully disaggregated probabilistic choice analysis. Transportation Research Part B 19B(4), 287-301.

Callon, M., 1986. The Sociology of an Actor-Network: The Case of the Electric Vehicle. In: M. Callon, J. Law and A. Rip (Eds.), Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World, The Macmillan Press, London, 19-34.

Callon, M., 1991. Techno-economic networks and irreversibility. In: J. Law (Eds.), A Sociology of Monsters: Essays on Power, Technology and Domination, Routledge: London, 132-161.

Canzler, W., 1999. Changing speed? From the private car to CashCar Sharing. SPEED - A workshop on space, time and mobility, Copenhagen, 23-31.

Caperello, N. and Kurani, K. S., 2010. Households' Stories of Their Encounters with a Plug-in Hybrid Electric Vehicle. Transportation Research Board, 89th Annual Meeting, Wasington D.C, January 10-14, 2010,

CARB, 2003. Final Regulation Order: The 2003 Amendments to the California Zero Emission Vehicle Regulation. California Air Resources Board.

CARB, 2008. 2008 Proposed Amendments to the California Zero Emission Vehicle Program Regulations. California Air Resources Board.

Carrasco, J.-A. and Miller, E. J., 2009. The social dimension in action: A multilevel, personal networks model of social activity frequency between individuals. Transportation Research Part A: Policy and Practice 43(1), 90-104.

Carrasco, J. A., Hogan, B., Wellman, B. and Miller, E. J., 2008. Collecting social network data to study social activity-travel behavior: an egocentric approach. Environment and Planning B: Planning and Design 35(6), 961-980.

Carrasco, J. A. and Miller, E. J., 2006. Exploring the propensity to perform social activities: A social network approach. Transportation 33(5), 463-480.

Christakis, N. and Fowler, J., 2007. The spread of obesity in a large social network over 32 years. The New England Journal of Medicine 357(4), 370-379.

Cialdini, R. B., 2003. Crafting normative messages to protect the environment. Current Directions in Psychological Science 12(4), 105-109.

CNW, 2007. Dust to Dust: The energy cost of new vehicles from concept to disposal.

Cohen-Cole, E. and Fletcher, J., 2008a. Is obesity contagious? Social network vs. environmental factors in the obesity epidemic. Journal of Health Economics 27(5), 1382-1387.

Cohen-Cole, E. and Fletcher, J. M., 2008b. Detecting implausible social network effects in acne, height, and headaches: longitudinal analysis. BMJ 337(42), a2533.

Coleman, J., Menzel, H. and Katz, E., 1957. The diffusion of an innovation among physicians. Sociometry 20, 253-270.

de Haan, P., Peters, A. and Mueller, M., 2006. Comparison of Buyers of Hybrid and Conventional Internal Combustion Engine Automobiles. Transportation Research Record: Journal of the Transportation Research Board 1983, 106-113.

Degenne, A. and Forse, M., 1994. Introducing Social Networks. SAGE Publications, London

Duck, S., 1991. Diaries and Logs. In: B. Montgomery and S. Duck (Eds.), Studying Interpersonal Interaction, The Guildford Press, New York, 141-161.

Duvall, M., Browning, L., Santini, D., Vyas, A., Taylor, D., Markel, T., Graham, R., Miller, A., Frank, A., Schurhoff, R., Warf, W., Mirisola, L., Childers, C. and Bevan, A., 2002. Comparing the Benefits and Impacts of Hybrid Electric Vehicle Options for a Compact Sedan and Sport Utility Vehicles. EPRI, Report #1006892.

Duvall, M., Knipping, E., Alexander, M., Tonachel, L. and Clark, C., 2007. Environmental Assessment of Plug-In Hybrid Electric Vehicles, Volume 1: Nationwide Greenhouse Gas Emissions. EPRI, Report #1015325.

Efferson, C., Lalive, R., Richerson, P. J., McElreath, R. and Lubell, M., 2008. Conformists and mavericks: the empirics of frequency-dependent cultural transmission. Evolution and Human Behavior 29(1), 56-64.

Ehrnberg, E., 1995. On the definition and measurement of technological discontinuities. Technovation 15(7), 437-452.

English, A., 2009. 2012 Toyota plug-in Prius pre-production Test Drive. Popular Mechanics December 14, 2009.

EPRI, 2007. The Power to Reduce CO2 Emissions: The Full Portfolio.

Ewing, G. and Sarigollu, E., 2000. Assessing consumer preferences for clean-fuel vehicles: A discrete choice experiment. Journal of Public Policy & Marketing 19(1), 106-118.

Feld, S., Suitor, J. and Hoegh, J., 2007. Describing changes in personal networks over time. Field Methods 19(2), 218-236.

Fu, Y., 2007. Contact diaries: Building of actual and comprehensive personal networks. Field Methods 19(2), 194-217.

Gartman, D., 2004. Three ages of the automobile - The cultural logics of the car. Theory Culture & Society 21(4-5), 169.

Geertz, C., 1973. The Interpretation of Cultures. Basic Books, Inc., New York

Gergen, K. and Gergen, J., 1987. Narratives of Relationships. In: R. Burnett, P. McGhee and D. Clarke (Eds.), Accounting for Relationships: Explanation, Representation and Knowledge, Methuen, London, 269-288.

Giddens, A., 1984. The Constitution of Society -- Outline of the Theory of Structuration. University of California Press, Berkeley, CA.

Giddens, A., 1991. Modernity and Self-Identity: Self and Society in the Late Modern Age. Stanford University Press, Stanford, CA.

Gleick, P., 2007. Hummer versus Prius: "Dust to Dust" report misleads the media and the public with bad science. Pacific Institute.

Gonder, J., Markel, T., Thornton, M. and Simpson, A., 2007. Using global positioning system travel data to assess real-world energy use of plug-in hybrid electric vehicles. Transportation Research Record 2017), 26-32.

Gonder, J. and Simpson, A., 2007. Measuring and Reporting Fuel Economy of Plug-In Hybrid Electric Vehicles. WEVA Journal 1.

Graham, R., Unnasch, S., Kassoy, E., Counts, R., Powars, C., Browning, L., Santini, D., Vyas, A., Markel, T., Taylor, D., Smith, J., Kalhammer, F., Miller, A., Reisen, S., Frank, A., Schurhoff, R., Duvall, M., Kosowski, M., Bush, R. and Warf, W., 2001. Comparing the Benefits and Impacts of Hybrid Electric Vehicle Options. EPRI, Report #1000349.

Granovetter, M., 1973. Strength of weak ties. American Journal of Sociology 78(6), 1360-1380.

Granovetter, M., 1978. Threshold models of collective behavior. American Journal of Sociology 83(6), 1420-1443.

Green, D. P., 1992. The price elasticity of mass preferences. American Political Science Review 86(1), 128-148.

Hadley, S. and Tsvetkova, A., 2008. Potential Impacts of Plug-in Hybrid Electric Vehicles on Regional Power Generation. Oak Ridge National Laboratory,

Hannemyr, G., 2003. The Internet as hyperbole: A critical examination of adoption rates. Information Society 19(2), 111-121.

Heffner, R. R., 2007. Semiotics and Advanced Vehicles: What Hybrid Electric Vehicles (HEVs) Mean and Why it Matters to Consumers. Institute of Transportation Studies, University of California, Davis, UCD-ITS-RR-07-30.

Heffner, R. R., Kurani, K. S. and Turrentine, T., 2009. Driving plug-in hybrid electric vehicles: Reports from U.S. drivers of hybrid electric vehicles converted plug-in hybrid vehicles. Transportation Research Record 2139, 38-45.

Heffner, R. R., Kurani, K. S. and Turrentine, T. S., 2007. Symbolism in California's early market for hybrid electric vehicles. Transportation Research Part D-Transport and Environment 12(6), 396-413.

Hess, D., 2007. What is a clean bus? Object conflicts in the greening of urban transit. Sustainability: Science, Practice and Policy 3(1), 45-58.

Hirschman, E. C., 1980. Innovativeness, novelty seeking, and consumer creativity Journal of Consumer Research 7(3), 283-295.

Hirschman, E. C., 1981. Symbolism and Technology as Sources for the Generation of Innovations. Advances in Consumer Research 9, 537.

Hogan, B., Carrasco, J. A. and Wellman, B., 2007. Visualizing Personal Networks: Working with Participant-aided Sociograms. Field Methods 19(2), 116-144.

Jackson, T., 2005. Motivating Sustainable Consumption: A Review of Evidence on Consumer Behaviour and Behavioural Change. Sustainable Development Research Network, University of Surrey,

Kalhammer, F., Kopf, B., Swan, D., Roan, V. and Walsh, M., 2007. Status and Prospects for Zero Emissions Vehicle Technology: Report of the ARB Independent Expert Panel 2007. Prepared for State of California Air Resources Board,

Kang, J. and Recker, W., 2009. An activity-based assessment of the potential impacts of plug-in hybrid electric vehicles on energy and emissions using 1-day travel data. Transportation Research Part D: Transport and Environment 14, 541-556.

Kline, R. and Pinch, T., 1996. Users as agents of technological change: The social construction of the automobile in the rural United States. Technology and Culture 37(4), 763-795.

Kromer, M. and Heywood, J., 2007. Electric Powertrains: Opportunities and Challenges in the U.S. Light-Duty Vehicle Fleet. Sloan Automotive Laboratory, Massachusetts Institute of Technology, LFEE 2007-03 RP.

Kurani, K. S., Axsen, J., Caperello, N., Davies, J. and Stillwater, T., 2009a. Learning from Consumers: Plug-in Hybrid Electric Vehicle (PHEV) Demonstration and Consumer Education, Outreach and Market Research Program. 2007 Alternative Fuels Incentive Program, Institute of Transportation Studies, University of California, Davis, UCD-ITS-RR-09-21, UCD-ITS-RR-09-21.

Kurani, K. S., Axsen, J., Caperello, N., Davies, J. and Stillwater, T., 2009b. Learning from Consumers: Plug-in Hybrid Electric Vehicle (PHEV) Demonstration and Consumer Education, Outreach and Market Research Program. Institute of Transportation Studies, University of California, Davis, UCD-ITS-RR-09-21.

Kurani, K. S., Turrentine, T. and Sperling, D., 1994. Demand for electric vehicles in hybrid households: An exploratory analysis. Transport Policy 1(4), 244-256.

Kurani, K. S., Turrentine, T. and Sperling, D., 1996. Testing electric vehicle demand in 'hybrid households' using a reflexive survey. Transportation Research Part D 1(2), 131-150.

Kvale, S., 1996. Interviews: An Introduction to Qualitative Research Interviewing. SAGE, Thousand Oaks

Law, J., 1992. Notes on the theory of the actor network: Ordering, strategy, and heterogeneity Systems Practice 5(4), 379-393.

Law, J. and Hassard, J., 1999. Actor Network Theory and After. Blackwell, Oxford, UK

Lemoine, D. M., Kammen, D. M. and Farrell, A. E., 2008. An innovation and policy agenda for commercially competitive plug-in hybrid electric vehicles. Environmental Research Letters 3(1), 10.

Manski, C., 2000. Economic analysis of social interactions. The Journal of Economic Perspectives 14(3), 115-136.

Markel, T., Brooker, A., Gondor, M., O'Keefe, M., Simpson, A. and Thornton, M., 2006. Plug-in Hybrid Vehicle Analysis. National Renewable Energy Laboratory (NREL), NREL-MP-540-40609.

Markus, M. L., 1987. Toward a critical mass theory of interactive media: Universal access, interdependence and diffusion Communication Research 14(5), 491-511.

Marsden, P. V., 1990. Network Data and Measurement. Annual Review of Sociology 16, 435-463.

Marwell, G., Oliver, P. E. and Prahl, R., 1988. Social networks and collective action: A theory of the critical mass 3. American Journal of Sociology 94(3), 502-534.

Mau, P., Eyzaguirre, J., Jaccard, M., Collins-Dodd, C. and Tiedemann, K., 2008. The `neighbor effect': Simulating dynamics in consumer preferences for new vehicle technologies. Ecological Economics 68(1-2), 504-516.

McCarthy, R. and Yang, C., 2010. Determining marginal electricity for near-term plug-in and fuel cell vehicle demands in California: Impacts on vehicle greenhouse gas emissions. Journal of Power Sources 195(7), 2099-2109.

McCarty, C., Molina, J., Aguilar, C. and Rota, L., 2007. A comparison of social network mapping and personal network visulalization. Field Methods 19(2), 145-162.

McCracken, G., 1988. The Long Interview. Sage Publications, Newbury Park, California

Metts, S., Sprecher, S. and Cupach, W., 1991. Retrospective Self-Reports. In: B. Montgomery and S. Duck (Eds.), Studying Interpersonal Interaction, The Guildford Press, New York, 162-178.

Moore, G., 1999. Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers. Collins Business Essentials, New York, New York

NAS, 2009. Transitions to Alternative Transportation Technologies -- Plug-in Hybrid Electric Vehicles (Pre-Publication). The National Academies Press, Washington, D.C.

Nesbitt, K., Kurani, K. S. and DeLuchi, M., 1992. Home recharging and the household electric vehicle market: A constraints analysis. Transportation Research Record 1366(11-19.

Oliver, P. and Marwell, G., 2001. Whatever happened to critical mass theory? A retrospective and assessment. Sociological Theory 19(3), 292-311.

Oliver, P., Marwell, G. and Teixeira, R., 1985. A theory of the critical mass 1. Interdependence, group heterogeneity, and the production of collective action American Journal of Sociology 91(3), 522-556.

Paez, S. and Scott, D., 2007. Social influence on travel behavior: a simulation example of the decision to telecommute. Environment and Planning A 39(647-665.

Pentland, B. T. and Feldman, M. S., 2007. Narrative networks: Patterns of technology and organization. Organization Science 18(5), 781-795.

Pesaran, A., Markel, T. and Tataria, H. H., D., 2007. Battery requirements for plug-in hybrid electric vehicles: Analysis and rationale. 23rd International Electric Vehicle Symposium and Exposition (EVS-23), Anaheim, California, December 2-5, 2007,

Pinch, T. J. and Bijker, W. E., 1984. The social construction of facts and artifacts - Or how the sociology of science and the sociology of technology might benefit each other. Social Studies of Science 14(3), 399-441.

Potoglou, D. and Kanaroglou, P. S., 2007. Household demand and willingness to pay for clean vehicles. Transportation Research Part D-Transport and Environment 12(4), 264-274.

Revkin, A., 2008. The Obama energy speech, annotated. The New York Times Issue, August 5, 2008.

Robertson, T., 1971. Innovative Behavior and Communication. Free Press, New York

Rogers, E., 2003. Diffusion of Innovations (5th Ed.). Free Press, New York

Rogers, E. and Kincaid, D., 1981. Communication Networks: A New Paradigm for Research. Free Press, New York

Ryan, R. and Gross, N., 1943. The diffusion of hybrid seed corn in two Iowa communities. Rural Sociology 8(1), 15-25.

Samaras, C. and Meisterling, K., 2008. Life cycle assessment of greenhouse gas emissions from plug-in hybrid vehicles: Implications for policy. Environmental Science & Technology 42(9), 3170-3176.

Santini, D. J. and Vyas, A. D., 2005. Introduction of hybrid and diesel vehicles - Status within the life cycle of technology adoption. In: (Eds.), Energy and Environmental Concerns 2005, 18-25.

Schutt, R., 2004. Investigating the Social World. SAGE, Thousand Oaks

Sen, S., Gurhan-Canli, Z. and Morwitz, V., 2001. Withholding consumption: A social dilemma perspective on consumer boycotts. Journal of Consumer Research 28(3), 399-417.

Service, R., 2009. Hydrogen cars: Fad or the Future? Science 324, 1257-1259.

Silva, C., Ross, M. and Farias, T., 2009. Evaluation of energy consumption, emissions and cost of plug-in hybrid vehicles. Energy Conversion and Management 50(7), 1635-1643.

Sioshansi, R. and Denholm, P., 2009. Emissions Impacts and Benefits of Plug-In Hybrid Electric Vehicles and Vehicle-to-Grid Services. Environmental Science & Technology 43(4), 1199-1204.

Smith, A., 2005. The alternative technology movement: An analysis of its framing and negotiation of technology development. Human Ecology Review 12(2), 106-119.

Steg, L., 2005. Car use: lust and must. Instrumental, symbolic and affective motives for car use. Transportation Research Part a-Policy and Practice 39(2-3), 147-162.

Steg, L., Vlek, C. and Slotegraaf, G., 2001. Instrumental-reasoned and symbolic-affective motives for using a motor car. Transportation Research Part F 4(151-169.

Stephan, C. and Sullivan, J., 2008. Environmental and energy implications of plug-in hybrid-electric vehicles. Environmental Science & Technology 42(4), 1185-1190.

Stern, P., Dietz, T., Abel, T., Guagnano, G. and Kalof, L., 1999. A value-belief norm theory of support for social movements: The case of environmental concern. Human Ecology Review 6, 81-97.

Strang, D. and Soule, S. A., 1998. Diffusion in organizations and social movements: From hybrid corn to poison pills. Annual Review of Sociology 24, 265-290.

Struben, J. and Sterman, J., 2008. Transition challenges for alternative fuel vehicles and transportation systems. Environment and Planning B: Planning and Design 35(6), 1070-1097.

Thaler, R. H. and Sunstein, C. R., 2003. Libertarian Paternalism. The American Economic Review 93(2), 175-179.

Thompson, C., 2009. Is happiness catching? The New York Times Issue, September 13, 2009.

Train, K., 1980. The potential market for non-gasoline-powered automobiles. Transportation Research Part A: Policy and Practice 14A, 405-414.

Turner, V., 1969. The Ritual Process: Structure and Anti-Structure. Aldine Publishing, Chicago, Il.

Turrentine, T. and Kurani, K. S., 1996. Advances in Electric Vehicle Technology from 1990 to 1995: The Role of California's Zero Emission Vehicle Mandate. EPRI, TR-106274.

Turrentine, T., Sperling, D. and Kurani, K. S., 1992. Market Potential for Electric and Natural Gas Vehicles. Institute of Transportation Studies, University of California, Davis, UCD-ITS-RR-92-08.

Turrentine, T. S. and Kurani, K. S., 1998. Adapting Interactive Stated Response techniques to a self-completion survey. Transportation 25(2), 207-222.

Turrentine, T. S. and Kurani, K. S., 2007. Car buyers and fuel economy? Energy Policy 35(2), 1213-1223.

Tversky, A., 1969. Intransitivity of preferences. Psychological Review 76, 31-48.

Tversky, A., 1972. Elimination by aspects: A theory of choice. Psychological Review 79, 281-299.

Tversky, A. and Kahneman, D., 1974. Judgement under uncertainty: Heuristics and biases. Science 185, 1124-1131.

U. S. Congress, 2009. H.R. 1 American Recovery and Reinvestment Act of 2009. U.S. Government Printing Office, Washington, D.C., <http://purl.access.gpo.gov/GPO/LPS111758>.

USDOE, 2007. Plug-in Hybrid Electric Vehicle R&D Plan: Working Draft. Office of FreedomCAR and Vehicle Technologies, Energy Efficiency and Renewable Energy, U.S. Department of Energy.

USDOE, 2009. Alternative Fuels and Advanced Vehicles Center: Data, Analysis and Trends. http://www.afdc.energy.gov/afdc/data/vehicles.html, January 21.

Valente, T., 1995. Network Models of the Diffusion of Innovations. Hampton Press, Cresskill, New Jersey.

Valente, T., 2005. Network Models and Methods for Studying the Diffusion of Innovations. In: P. Carrington, J. Scott and S. Wasserman (Eds.), Models and Methods in Social Network Analysis, Cambridge University Press, New York, New York, 98-116.

Van den Bulte, C. and Lilien, G., 2001. Medical innovation revisited: Social contagion versus marketing efforts. American Journal of Sociology 106, 1409-1435.

van Rijnsoever, F., Farla, J. and Dijst, M. J., 2009. Consumer car preferences and information search channels. Transportation Research Part D: Transport and Environment 14(5), 334-342.

Wall, M., 1996. Valuing the characteristics of natural gas vehicles: An implicit markets approach. The Review of Economics and Statistics 78(2), 266-276.

Wasserman, S. and Faust, K., 1994. Social Network Analysis: Methods and Applications. Cambridge University Press, New York, New York

Williams, B. D. and Kurani, K. S., 2006. Estimating the early household market for light-duty hydrogen-fuel-cell vehicles and other "Mobile Energy" innovations in California: A constraints analysis. Journal of Power Sources 160(1), 446-453.

Zhou, W. X., Sornette, D., Hill, R. A. and Dunbar, R., 2005. Discrete hierarchical organization of social group sizes. Proceedings of the Royal Society B 272, 439-444.

Appendix A: First interview and personal network construction (outline)

(~2 hours)

Outline:
#1 – Paper work, study overview, outlet check, survey url, etc. (~20 minutes)
#2 – Brief vehicle purchase history (~40 minutes)
#3 – Social network construction and instructions for recruitment of contacts (~1 hour)

Brief Vehicle Purchase Narratives and Future Intentions
(`~40 minutes)
(Adapted from Heffner et al.)

[Prior to this interview, respondents will be provided some optional "homework" to start constructing their vehicle purchase history, and to start generating names for their social network.]

1. Overview
1.1 Elicit currently owned vehicles, and potentially several previously owned (participant may already have some/all details prepared)
1.2 Include details:

- Year/Make/Model
- Years bought and sold (if applicable)
- Bought new, used, or leased
- Replaced what and/or why replaced?
- Main uses
- Main user

1.3 Select one or more vehicles to focus on for the rest of this section—likely the most recently purchased vehicle, perhaps another currently owned vehicle, and potentially another vehicle from the respondent's history if they seem particularly excited about it. (Probably best to stick to just the one vehicle, maybe a second if we need to engage another driver.)

2. Vehicle Purchase
2.1 Storytelling: tell me how you came to purchase this vehicle. Initially leave it open for an undirected narrative, but potentially prompt with:

- description of events
- events provoking interest
- point when respondent decided to make purchase
- how vehicle is optioned
- purchase drivers
- symbolic meaning
- information sources (referents)

2.2 What other vehicles did you consider during the purchase of this vehicle (if any)?
- reasons, perceived advantages/disadvantages
- did you consider another type of vehicle? (E.g. compact, pickup, SUV, HEV…)

2.3 Did you consult anybody else during this process? For advice? To hear their experience? Or just to bounce some ideas off them?

3. Symbolic benefits
(Depending on time, and what is said in 2 above, maybe just stick to points 3.1 and 3.2)
3.1 Who buys a vehicle like this?
3.2 Does your car say anything about you? When people see you in this car, what do they think?
3.3 Would a hybrid say something different?
3.4 Can you remember a time when you thought "I'm so glad I bought this car"?
3.5 Do others (friends, family, etc.) know what kind of car you drive? Who? How?
3.6 Have you talked to strangers about your car?
3.7 What do you think about SUVs in general? Would you own a (non-hybrid) SUV?

4. Benefits
4.1 Distill main purchase motivators and confirm with subject. (Priorities are relative.)
4.2 Potentially prompt/explore importance of potential pro-societal advantages, if brought up by the participant:
- reduced pollution
- less global warming emissions
- fuel cost savings (now or in future)
- reduced resource use
- inspire other
- demonstrate "values"

4.3 Evaluating purchase drivers (for each elicited motivator)
- why was this important to respondent?
- what was respondent's knowledge level?
- what were respondent's other supporting behaviors?
- why was chosen vehicle better than those in choice set?
- why were other alternatives excluded? Other fuels? Other vehicle body styles?

5. Disbenefits
5.1 When purchasing the vehicle, what problems did you see?
5.2 Why important? (Coping strategy?) (For each elicited disadvantage)

6. Future vehicle purchase intention
6.1 When do you anticipate your next vehicle purchase?
6.2 Details:
- new or used?
- replace an existing car or add to fleet?
- potential models?
- HEV or alternative vehicle considered?

6.3 Sources of information for this intention?
6.4 What additional sources of information might you consult before purchase?

Vehicles				Year	Travel	Residence	Household
				2001			
				2002			
				2003			
				2004			
				2005			
				2006			
				2007			
				2008			
				2009			

Part II: Constructing the personal network (60 minutes)
(Adapted from Hogan et al., 2007 and Carrasco et al., 2008)

Props:
"Name generator" instrument:
- single piece of paper (8.5 x 11 inches)(Hogan, et al., 2007)
- two pieces of cardstock (8.5 x 11 inches) with three windows cut out
- 66 Post-it Ultra page markers (cut to 0.5 x 1.75 inches), 33 on each side of the plain paper (different colors on each side)
- printed definitions of "very close" and "somewhat close"
- one piece of paper with 8 different role categories

"Sociogram space":
- Single sheet of paper (22 x 17 inches) with 4 concentric circles printed onto it (one inch apart).
- Bulletin board backdrop (about 23 x 16 inches of cork)

Example of progression to final product (building a sociogram):

Interview protocol
(described below for one respondent, but could be scaled to allow 2 or more household members to construct their own sociograms)

Explaining the rationale for this exercise to respondents:

"The overall goals of this study are to allow you to assess this PHEV and to learn from you how such a vehicle may or may not fit into your life. As part of this, we would like to find out some specific information about your connections to other people that may affect your evaluation of this vehicle."

We are going to ask you to construct a diagram of your social circle, indicating people you know, how close they are to you, and how close they are to each other.
- Your list/diagram will be kept confidential
- Use first names (and/or initials to keep it confidential)
- We will not try to contact any of the people you identify (though we may ask you to later—this would be voluntary)
- We will not show your list/diagram to anybody in your list

1. Generating names
1.1 Eliciting network members:
- provide respondent with definitions of two types of personal contacts:

Very close: discuss important matter with, or regularly keep in touch with, or there for you if you need help.

Somewhat close: more than just casual acquaintances, but not "very close."

- ask respondent to think of as many "very close" contacts as they can
- instruct the respondent to write the first names of these contacts on the post it notes arranged on the "name generator" instrument, starting with those closest to them
- prompt respondent to flip over the "name generator" instrument to repeat with "somewhat close" contacts

(allow respondent to flip back and forth if necessary)

1.2 Roles of each person
- Once the respondent is finished generating names, present this list of role categories:
  i) immediate family
  ii) other relatives
  iii) neighbors
  iv) people you currently go to work/school with
  v) people you know online
  vi) people from organizations (e.g. bowling, club, church, team)
  vii) friends not included above
  viii) other
- See if this list prompts the respondent to recall additional contacts
- Ask respondent to assign at least one role to each generated contact by writing the corresponding number beside their name (multiple roles are permissible)

2. Locating very-close and somewhat-close names in sociogram
- present the sociogram space to the respondent
- instruct the respondent to place name tags as follows:
  i) place tags on the lines, not between them
  ii) the circles represent closeness, so place the closest people to you on the inner circle and work outward.
  iii) place people who know each other close together
  iv) rearrange tags until you are satisfied
- provide further demonstration/explanation as necessary

3. Tie connectivity
- instruct the respondent to further symbolize the ties among contacts

Draw a solid line circle around
- groups of people (3 or more) who are "very close" to each other

Draw a dotted line circle around
- groups of people who are "somewhat close" to each other

Draw a solid line connecting
- two people who are "very-close"

Draw a dotted line connecting
- two people who are "somewhat close"

4. Vehicle purchase contacts

4.1 List any people that you haven't yet mentioned that:
i) if you were going to purchase a vehicle, that you would **consult or have a discussion (or bounce ideas off, or seek opinions)** regarding your purchase decision.
ii) would consult you if they were going to purchase a vehicle

4.2 For all people on your diagram:
i) put a gold star next to those that you would consult if you were going to make a vehicle purchase
ii) put a silver star next to those that would consult you

5. Contacting other network members
5.1 Recruiting individuals from network (preferably "very close" contacts)
5.2 Incentives: monetary and the chance to take part in PHEV trial
5.3 Provide business cards and/or contact instructions

Part III: Next Steps (`~15 min)

1. Contacting other network members
1.1 Intentions of the study
1.2 Recruiting individuals from network (preferably "very close" contacts)
1.3 Incentives: monetary ($50) and the chance to take part in PHEV trial
1.4 Provide business cards and/or contact instructions

2. Social episode diary
2.1 Show and describe social episode diary (and purpose)

Appendix B: PHEV survey part 1 (online questionnaire)

Section 1: Household Vehicle Information

1) How many vehicles does your household currently own, that are driven at least once per week?
2) Of your household vehicles that you purchased new in the last 6 years,
please enter the year, make and model of the vehicle that your household drives most often:
3) What was the price of your _______ when your household bought it?
4) How is your _______fueled?
5) When you think about or discuss the fuel used by your _______, which of the following measures of fuel use are you most comfortable with?
6) If you know the typical MPG of your _______please enter this value below:
7) What was the price of fuel the last time your _______was fueled?
8) Which of the following does your _______'s dashboard tell you about your use of fuel?
9) Does your household do any of the following to keep track of fuel use or fuel spending in your household's vehicles?
What is the main reason that your household tracks vehicle fuel use or spending?
For which vehicle(s) does your household track fuel use or spending?
10) On average, how much does your household spend on fuel for your _______?
How much has this amount changed from Week to Week over the last year?
Highest/Lowest Amounts:
If we compared the estimates you made in the previous two questions (above) with your actual fuel spending over the past year, how accurate would your estimates be?
11) If for any reason the world could no longer use gasoline and diesel, what fuel will most likely succeed as a replacement for use in personal vehicles?
Which statement best explains why you chose _______as the best fuel for personal vehicles? (other than gasoline/diesel)

Section 2: Electricity Use

1) When you think about or discuss the electricity used by your household, which of the following measures of electricity use are you most comfortable with?
2) Which of the following statements best summarizes your understanding of the term: kilowatt-hour (kWh)?
3) How much did your household spend on electricity on your latest bill?
Highest/Lowest Amount:
How did you answer the above questions about how much you spent on your electricity bill?
4a) Do you know what price per kilowatt-hour (kWh) your household was charged on your last electricity bill?
Please enter the highest and lowest prices you were charged below:
Lowest/Highest Price:
How did you answer the above question about the charge per kilowatt-hour (kWh) on your electricity bill?

5) Under what conditions does the price you are charged for electricity change?
How did you answer the above question about the charge per kilowatt-hour (kWh) on your electricity bill?
6) From which of the following energy sources do you think your home's electricity comes from?
7) Now think about the environmental impacts of these energy sources. Different regions of the US use different energy sources. How do the energy sources used in your region compare with the energy sources used to produce electricity in the rest of the US?
8) How likely is it that the price of electricity will double from today's price at some point in the next 10 years?
How likely is it that the price of gasoline/diesel will double from today's price at some point in the next 10 years?
9) How likely is it that the supply of electricity will become so low that at some point in the next 10 years, your household will be limited in how much electricity it can use?
How likely is it that the supply of gasoline will become so low that at some point in the next 10 years, your household will be limited in how much gasoline it can use?
10) Do you have experience with plugging any of the following vehicle technologies into an electrical outlet?
At which of the following location(s) do you have experience plugging in this vehicle technology (or technologies)?

Section 3: Vehicle Technology
1) How familiar are you with the following vehicle technologies? In other words, do you understand how you would drive and refuel them, and what makes them different from each other? (CV, EV, HEV, PHEV)
2) From what you understand of these vehicle technologies, which can use fuel, and which can be plugged in?
3) Can you name a hybrid-electric vehicle that is currently being sold in the US?
4) You may have seen hybrid-electric vehicles and you may have thought about why people buy them. What do you think is the major reason that people buy hybrid-electric vehicles?
5) Which of these reasons (if any) would most likely encourage you to buy a hybrid-electric vehicle?
6) Which of the following statements best summarizes your consideration of a hybrid-electric vehicle when you bought your _______?
7) Have you ever spoken with an owner of one of these vehicles?
8) Prior to this survey, you probably had ideas of what these vehicle technologies were. What sources of information helped you to form your ideas about electric, hybrid electric, and/or plug-in hybrid vehicles?
9) If you wanted to find out more about electric, hybrid-electric, or plug-in hybrid vehicles, which one of the following sources would you consider to be most important to you?
10) The future design of this (PHEV) technology is uncertain. However, do your best to indicate your level of agreement with the following statements, given your current impressions of this technology.

> "My household could save a lot of money with this plug-in technology."
> "My household would find it very difficult to find electric outlets to plug in such a vehicle."

“This plug-in technology will not fix any environmental problems, even if everyone in the US drove one.”
“Overall, this plug-in technology is a bad idea.”
“The next time my household buys a new vehicle, we would pay extra for a vehicle with this plug-in technology.”

11) You are offered the choice between two ways to reduce your household's energy use. Both simply require you to install them and then carry on with you usual life. Both are offered to you free. Which would you choose?
Option A would reduce electricity use in your home, reducing your monthly utility bill by $21.
Option B would reduce gasoline use in your vehicles, reducing what you pay each month for gasoline by $21.

Section 4: Global Issues

1) Which of the following statements is closest to your opinion on: global warming (climate change)?
2) Which of the following statements is closest to your opinion on: air pollution?
3) Which of the following statements is closest to your opinion on: the dependency of the US on foreign oil?
4) In your opinion, which of the following statements about global warming (climate change) is most accurate?
5) Do you think that the earth's climate is warming due to greenhouse gas emissions?
6) Who do you think should take primary responsibility for reducing greenhouse gas emissions?
7) Which of the ideas below is the best strategy for government to take to reduce the greenhouse gases released by fossil fuel use?
8) Which of the following actions would you take to reduce greenhouse gas emissions from fossil fuel use?

Section 5: Your Household

1) How many people live in your household (including yourself)?
2) Please provide a brief description of the members of your household:
3) What is the highest level of education you have completed?
4) What pre-tax income category does your household fit into?
5) How quickly does your household typically buy a 'new technology', relative to most households?
6) Now repeat this question, but think only of vehicles. Consider all the new vehicle models that have become available over the last decade, and the new gadgets and other advancement that have become available.

Appendix C: Pre-Interview Questionnaire

1) Select up to four of your household's most recently purchased vehicles.
(This list may include vehicles you no longer own.)
Provide the following *details* for each vehicle (leave blank any cells that don't apply):

Vehicle	#1 (most recent)	#2	#3	#4
Model year				
Make				
Model				
Year purchased				
Year sold (If applicable)				
Bought new, used or leased?				
What vehicle did it replace?				
Which vehicle replaced it?				
What are/were the main *uses* of the vehicle?				
Who are/were the main *users* of the vehicle?				

2) Now focus on your most recently purchased vehicle.
Please *select two or more pictures* that express the thoughts and feelings that come to your mind when thinking about this vehicle. These pictures may come from any source such as a magazine, newspaper, the Internet, or even photographs you have taken yourself. You don't need to send these pictures to us, but please have them ready for your interview.

3) Connections to other people.
The overall goals of this study are to allow you to assess an advanced vehicle technology and to learn from you how such a vehicle may or may not fit into your life. As part of this, we would like to find out some specific information about your *connections to other people* that may affect your evaluation of this vehicle.

Using first names only, please *list all the people* that you would consider to be "very close" or "somewhat close" to you, defined as follows:

Very close: someone you discuss important matter with, or regularly keep in touch with, or is there for you if you need help.
Somewhat close: someone who is more than just a casual acquaintance, but not "very close."

(If more than one driver from your household is participating in this study, please include connections for each driver.)

Very close people	**Somewhat close people**

(Please continue list on separate piece of paper if necessary)

Appendix D: Recruitment instructions

Inviting your friends, family and other social contacts to take part:

Why invite them?

The overall goals of this study are to allow you to assess an advanced vehicle technology and to learn from you how such a vehicle may or may not fit into your life. As part of this, we would like to learn about your connections to other people that may affect your evaluation of this vehicle.

Who to invite?

In the first week of the study, please choose 5 to 10 people (per driver) to invite from your social network:

Driver #1:	Driver #2:
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

During the rest of the study, please invite anybody else that you come into contact with, even casual acquaintances or strangers.

How to invite them?

You can invite your friends using three different methods—please choose the method that best fits the circumstances:
In person: give them one of our business cards.
By phone: tell them our contact information (cell: 530-574-2150, email: jaxsen@ucdavis.edu)
By email: forward the email invitation that we send you.

What's in it for them?

Additional participants will be helping us to better understand the needs of drivers in the U.S.
We will also provide gift cards as compensation—the value of these gift cards will depend on their level of participation:
$50 for completing a 2-part online survey
$100 for completing the above plus a 30-minute phone Interview

Appendix E: Recruitment email

Hello X:

Thanks for your interest in our study!

Please read the project description and participation requirement. If you are interested (and eligible) to join our study, please click on the link below to begin Part 1 of the online survey (or copy and paste into your browser).

Study Summary:
Researchers at the University of California, Davis are interested in consumer responses to vehicles that run on different kinds of energy and fuels. Currently, we are placing vehicles into households in the greater Sacramento area. We ask the drivers of these vehicles to invite other people to also talk with us (though we won't be able to give you a vehicle to drive). You are invited to complete a two-part online survey and potentially a 30-minute phone interview.

Benefits:
You will be helping us to better understand the needs of drivers in the U.S. We will also provide a gift card as a token of thanks—the value of this gift card will depend on how much you participate:
$10 for completing a 20-minute online survey
+$20 for completing another 30-minute online survey (and one-day driving diary)
+$20 for conducting a 30-minute phone interview (upon invitation)—will be recorded

Survey Description:
The survey has three parts, and will take a total of 1 hour to 1.5 hours, spread over several weeks (past participants have found it to be fun):
Part 1: Online questionnaire (15-25 minutes)
Part 2: One-day driving diary (30 minutes)
Part 3: Online vehicle design game (20-30 minutes)

Eligibility:
To participate in this study, you must meet each of the following criteria:
1) You were invited by one of our vehicle trial participants (which you were)
2) You are age 19 or older
3) You own a vehicle you drive at least once per week
4) You are comfortable using the Internet (for a web-based survey)
(If you do not meet points #3 or #4 above, the online survey won't apply to you. However, we may still like to contact you for a phone interview if you are interested -- let us know.)

Confidentiality:

All collected data will be kept confidential according to established procedures at UC Davis, and you will only be contacted for research that you want to be considered for. As noted above, some survey participants will be invited for a follow up interview by phone.

Part 1 will take about 15-25 minutes to complete—please complete in a single sitting. Please complete Part 1 before XXXXX. (Please contact me if you encounter any technical problems.)
http://survey.its.ucdavis.edu/vehicle/part3/intro.php?uid=XXXXX

Feel free to contact me if you have any questions.

Cheers,
Jonn Axsen
jaxsen@ucdavis.edu
cell: 530-574-2150

Appendix F: Social Episode Diary

Vehicle Discussion Diary

Instructions:

Thank you for participating in this UC Davis study!

While you have the plug-in hybrid electric vehicle (PHEV), you might talk about the vehicle, your experience, related ideas, or anything else about such a car with friends, family, co-workers, parents of your childrens' friends, complete strangers, or any one else. Examples include:

- You talk with a friend about the study.
- You take a co-worker for a test-ride in the car. (Remember though, only you and the authorized members of your household may drive the car.)
- A stranger asks you about the vehicle in a parking lot
- Your neighbor asks about the cord running from the car to your garage.

Whenever you talk with *anyone* about the PHEV, or about cars and trucks in general while you have the PHEV, please take some notes about the conversation in this diary.

Please update your diary on a daily basis, such as at a regular time each day.

For each conversation, please note the following information:

- Date and time of day
- Who was involved in the conversation? (and who initiated it?)
- Where did it take place?
- What was said by each person? (Just of couple notes, we aren't expecting you to write down all your conversations word-for-word!)

This diary contains 18 pages for you to record your conversations. A full page is provided for each entry—feel free to use as much space (or as little) as you need to summarize the experience.

If you need more space than is provided in this booklet, or prefer to record information in a different manner, feel free to adapt this layout or use additional paper to meet your needs.

<table>
<tr><th>Details:</th><th>Content: (What did you discuss?)</th></tr>
<tr><td>EXAMPLE
Date: 11/08/2008
Time: 12:15pm to 12:30pm
Who: Jacob and Jennifer
Place: Cafeteria at my workplace</td><td>(Hypothetical example)
Jennifer, Jacob and I were sitting together for lunch as we normally do on weekdays.

Jacob started talking about the PHEV. He said he had heard I was driving a car that can plug in, and asked: “why does your car have a plug?”</td></tr>
<tr><td colspan="2">I told him that I am participating in a study with UC Davis, and I am driving a plug-in hybrid vehicle that can run on gasoline or electricity.

Jennifer said she had heard about these cars, and that they could get very high fuel economy. She asked me if this was true.

I replied that I have only just started driving this vehicle, and that I don’t have a sense of gasoline use just yet.

Etc…</td></tr>
</table>

Details:	**Content:** (What did you discuss?)
#1 **Date:** **Time:** **Who:** **Place:**	

Appendix G: Plug-in Hybrid Vehicle Guide

Your Plug-In Vehicle Guide

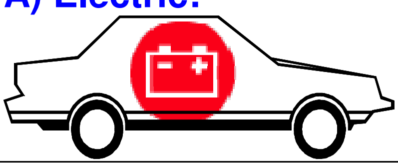
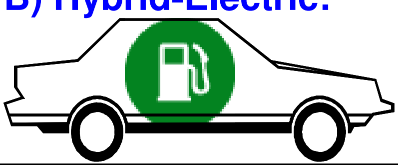
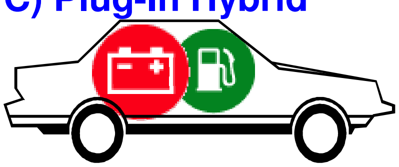
Your Plug-In Hybrid Guide:

Why read this guide?

Think of this as a 10 minute shopping guide. Part 3 of the 'Household Vehicle Survey' will allow you to design your own plug-in hybrid vehicle. You will determine how this technology might fit into your household's lifestyle, if at all. This guide explains the design options you will be given in Part 3.

This Guide Focuses on Plug in Hybrid Vehicles ONLY

A plug-in hybrid is a combination of an electric vehicle and a hybrid-electric vehicle. Recall the descriptions you were provided in Part 1 of the survey:

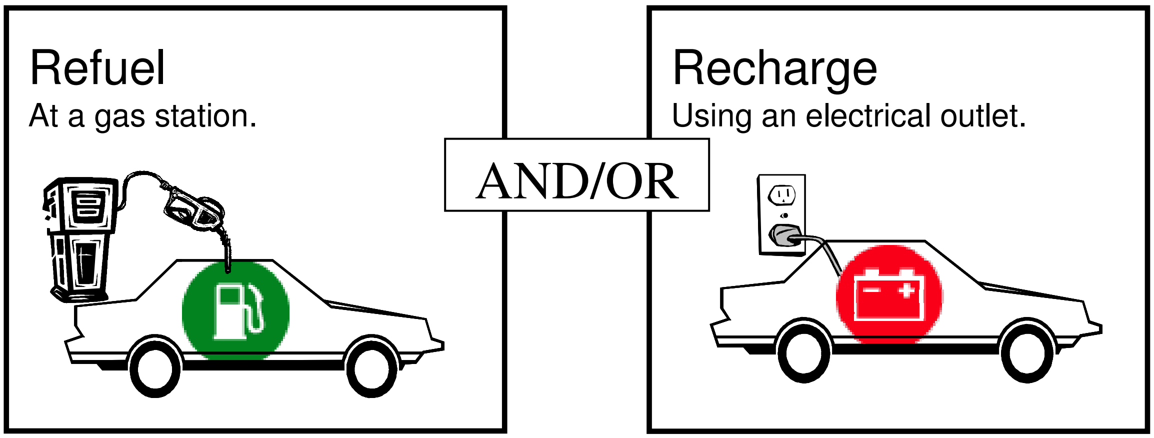
Vehicle Type	Description
A) Electric: 	An electric vehicle is fueled by **electricity only**. It is charged by plugging in to an electric outlet. The electricity is stored in the vehicle until it is used to power the vehicle. This technology is not currently produced by any major car companies, but a few smaller companies do.
B) Hybrid-Electric: 	A hybrid-electric vehicle is fueled by **gasoline only**. It uses a hybrid-electric technology to use gasoline more efficiently. A hybrid-electric vehicle can **not** be plugged in to an electric outlet. This technology includes the Toyota Prius, which has become quite popular in the US.
C) Plug-In Hybrid 	A plug-in hybrid combines these two technologies. It can be plugged in to an electric outlet to charge up with electricity, and it can be filled with gasoline. A plug-in hybrid **can run on electricity only, gasoline only, or a combination of the two**. No car company currently sells this technology, although several have plans.

(***Note:** This guide refers to 'gasoline' as your vehicle fuel, but this term includes whatever fuel your current vehicle uses, including diesel or ethanol)

Lesson 1: Refueling and Recharging

The plug-in hybrid is unique because it can be refueled with gasoline *and* recharged with electricity. Unlike a basic electric vehicle, the plug-in hybrid will still drive if it runs out of electricity (as long as you have gasoline left).

Refueling and recharging your vehicle is simple:



Gasoline: Refueling

Refuel at any gasoline station. You have the same fuel tank you are used to, which holds the same amount of gas. If you want, you could use *only* gasoline all the time without ever plugging in, just like your current vehicle.

Electricity: Recharging

Recharge your vehicle using any normal electrical outlet (110-volt) – just like you recharge your cell phone or laptop computer. These are the same types of outlets you use for a TV or toaster. An outlet might be at home, work, a store or a friend's house, and would likely be outside or in a garage.

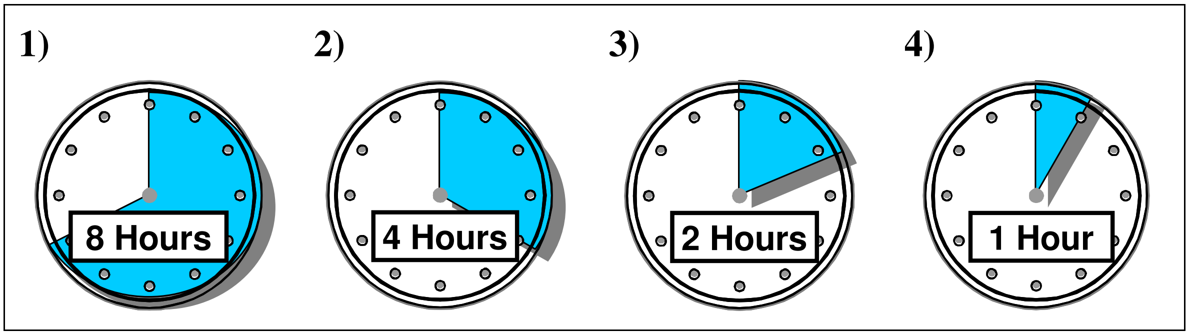
Why plug-in when I could just use gasoline?

Electricity is generally **cheaper** than gasoline…but it is difficult to say how much cheaper. Gasoline prices change often, and electricity prices vary by region, season, and other factors. In most regions today, driving with *only* electricity would cost 60-80% less per mile than driving with *only* gasoline. This saving is like reducing your gas cost from $3.00/gallon to around $1.00.

Also, driving with electricity usually causes **less air pollution and greenhouse gas emissions** than driving with gasoline. The size of these reductions depends on how your electricity is produced.

How long does it take to recharge?

Recharge time depends on the vehicle design you choose. An empty battery could take 1 to 8 hours to fully recharge. In Part 3 of the survey, you will be given the following four upgrade options when you design your own plug-in hybrid vehicles:



Can I interrupt the recharging process?

Yes. For instance, if your vehicle requires 8 hours for a full charge, and you unplug it after 2 hours, you will get one quarter of a full charge. Similarly, you could plug it in for only 1 hour, or even 10 minutes.

EXAMPLES: Recharge Upgrades

Think of **Paul** and **Sarah**, two different drivers who each designed their own plug-in hybrid vehicles. Each driver completed a *Plug-In Vehicle Diary* to see what opportunities they have to recharge (access to electrical outlets).

Paul's family has only one place where they can recharge their vehicle: at their home garage where they park every night. Because Paul can recharge for 12 hours a day, he chose not to improve recharge time beyond 8 hours.

Sarah lives in an apartment building, where there are no electric outlets near her parking spot. She drives around on business frequently during the day time, where she may occasionally be parked near an electrical outlet for 1-2 hours at a time. Because she has only brief opportunities to recharge, Sarah chose to upgrade her plug-in vehicle recharge time to the quickest choice: 1 hour.

Lesson 2: Gasoline Mode (Driving Without Electricity)

All plug-in hybrid vehicles can drive without electricity. Once the battery runs out, the vehicle continues by using gasoline only. You *could* drive your plug-in vehicle without *ever* plugging in.

'Gasoline' Mode: Efficiency Upgrade

A bonus of a plug-in hybrid vehicle is that once the electric charge runs out, the vehicle switches to 'Gasoline' mode and behaves just like a typical hybrid electric vehicle (like a Toyota Prius). This means that even if you don't plug-in, a plug-in hybrid vehicle uses less gasoline than a regular vehicle. At a minimum, 'Gasoline' mode will allow you to drive an extra 10 miles per gallon (+10 MPG) over a typical vehicle. If your current vehicle can travel 27 miles with a gallon of gasoline, the plug-in version could travel at least 37 miles.

You will have 3 options to improve the efficiency of 'Gasoline' mode:

1) Current Vehicle +10 MPG | **2) Current Vehicle +20 MPG** | **3) Current Vehicle +30 MPG**

Each improvement is relative to your current vehicle. If your current vehicle can drive 30 miles per gallon of fuel, you can upgrade 'Gasoline' mode efficiency to 40, 50 or 60 miles per gallon.

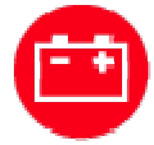
EXAMPLES: Upgrading Gasoline Mode

Again think of **Paul** and **Sarah**, who both vehicles that originally had a fuel efficiency of 27 miles per gallon (MPG).

Paul's family doesn't drive in 'Gasoline' mode very often because they can recharge regularly at home. He chose the minimum upgrade of **37 MPG.**

Sarah chose the maximum 'Gasoline' mode upgrade of **57 miles per gallon**. She is interested in saving money, and she knows that on many days she can't recharge at all. She wants to maximize her fuel savings even when she can't use electricity.

Lesson 3: Electric Mode (Driving With Electricity)



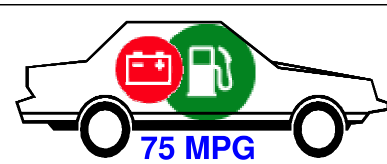
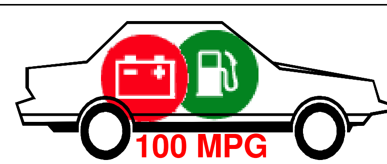
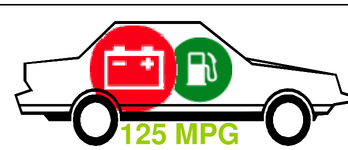
If you recharge your plug-in vehicle, you can drive for some distance using electricity. Depending on your chosen design, electricity would either *reduce* gasoline use (Electric Assist) or *replace* gasoline use (All Electric) for this limited distance.

Note: For all upgrades discussed in this guide, the vehicle's performance does not change. For instance, improving gasoline efficiency or electricity use does not reduce acceleration, horsepower, top speed or towing ability.

Electric Assist: Reducing Gasoline Use

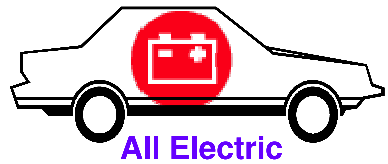
When recharged, a vehicle that is 'Electric Assist' capable will use both electricity and gasoline at the same time. The electricity *helps* the gasoline engine, offsetting the gasoline required to drive. For instance, an average car can travel 27 miles with a gallon of gasoline (27 MPG). However, a charged plug-in hybrid can travel at a rate of at least 75 miles per gallon of gasoline (75 MPG), because the electricity is helping. Once the battery runs out, the vehicle returns to using gasoline only. You will *not* be stuck!

There are **3 types** of 'Electric Assist' plug-in hybrid vehicles. More advanced types use more electricity and less gasoline (represented by the changing size of the battery and gasoline icons in the diagrams below).

Type #1: Electric Assist (75 MPG) Where electricity *helps* the gasoline engine, improving your gas mileage to **75** miles per gallon (MPG). *Some* gasoline is always required to drive.	
Type #2: Electric Assist (100 MPG) Same as above, but improving your gas mileage to **100** miles per gallon (MPG). *Some* gasoline is always required to drive	
Type #3: Electric Assist (125 MPG) Same as above, but improving your gas mileage to **125** miles per gallon (MPG). *Some* gasoline is always required to drive	

All Electric: Temporarily Replacing Gasoline Use

A fourth type of electric design is 'All Electric' capable. This technology is more advanced than the 'Electric Assist' options because electricity can fully replace the use of gasoline for a limited distance. Once the battery has run out, the vehicle returns to using gasoline only. You will *not* be stuck!

Type #4: All Electric Where electricity is temporarily used *instead* of gasoline. As long as the vehicle is charged up, no gasoline is required to drive.	

How long does the Electric Charge last?

You can choose the distance your electric charge will last. This distance does not change if you choose Type #1, #2, #3 or #4. You can choose to have a full charge last for the *first* 10, 20 or 40 miles of travel. Beyond this distance, your vehicle returns to 'Gasoline' mode. If you choose 20 miles, your fully charged vehicle will drive in electric mode for the first 20 miles ('Electric Assist' or 'All Electric').

When Fully Charged Drive in 'Electric Assist' or 'All Electric' Mode:		
1) For the First 10 Miles	**2) For the First 20 Miles**	**3) For the First 40 Miles**

EXAMPLES: Upgrading Electric Mode and Electric Distance

Again think of **Paul** and **Sarah**, two different plug-in hybrid owners.

Paul likes the idea of driving an electric car in the city, so he chose a **'Type #4: All Electric'** capable vehicle. He lives 6 miles from work (12 miles round trip), so he chose a vehicle with **10 miles** of distance per charge. He can recharge each night, then commute to work, and most of the way home with only electricity. His vehicle switches to 'Gasoline' mode for the last 2 miles of his commute.

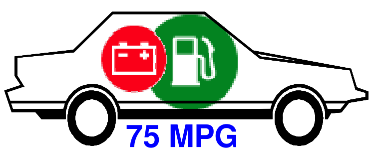
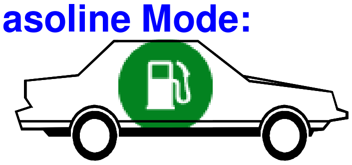
Sarah does not care if she uses gasoline or electricity; she just wants to save money. She chose the 'Electric Assist' capability, as she doesn't think 'All-Electric' mode is worth the extra cost. She chose **'Type #2: Electric Assist (100 MPG)'** so she can drive at a rate of 100 miles per gallon of gasoline (MPG). She also chose to upgrade to **40 miles** of distance per charge, because she knows she cannot recharge regularly.

Lesson 4: Upgrading Your Plug-In Vehicle

Minimum Upgrade Package

In Part 3 of the survey, you will use an interactive diagram to design your ideal plug-in hybrid vehicle (given different constraints). The diagram below shows the baseline plug-in upgrade package you will be shown, with the minimum values shown for each option:

This plug-in hybrid vehicle requires **8 hours** to fully recharge. When charged, it can drive with **'Type #1: Electric Assist (75 MPG)'** for the first **10 miles**. After 10 miles, the vehicle switches to gasoline mode, which can travel 10 more miles per gallon (MPG) of gasoline than your current vehicle.

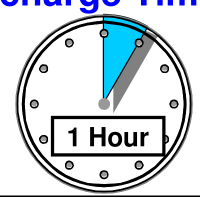
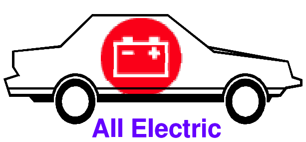
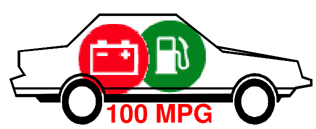
Your Plug-In Hybrid Vehicle	Upgrades
Recharge Time:  8 Hours	**Time to Fully Recharge:** ● 8 Hours ○ 4 Hours ○ 2 Hours ○ 1 Hour
Electric Mode:  75 MPG Electric Assist **For the First 10 Miles**	**Electric Capability:** ● Type #1: Electric Assist (75 MPG) ○ Type #2: Electric Assist (100 MPG) ○ Type #3: Electric Assist (125 MPG) ○ Type #4: All Electric
	Distance With Electric Capability: ● First 10 miles ○ First 20 miles ○ First 40 miles
Gasoline Mode:  **Your Vehicle +10 MPG**	**Gasoline Use:** ● +10 Miles Per Gallon ○ +20 Miles Per Gallon ○ +30 Miles Per Gallon

EXAMPLES:

Here is a summary of the plug-in upgrades **Paul** and **Sarah** chose:

Paul's family chose a plug-in vehicle that takes 8 hours to fully recharge. When fully charged, the vehicle can drive without any gasoline (Type #4: All Electric) for the first 10 miles. After 10 miles (unless recharged), the vehicle runs out of electricity and uses gasoline only (37 MPG), but still saves fuel compared to a regular vehicle (+10 miles per gallon).

Sarah chose a plug-in vehicle that takes only 1 hour to recharge. The fully charged vehicle can drive with Electric Assist (Type #2) for 40 miles, using electricity to boost fuel economy up to 100 miles per gallon. After 40 miles, the vehicle switches to gasoline only, where her vehicle can travel an extra 30 miles per gallon of gasoline (57 MPG) compared to a typical vehicle.

***Paul's* Upgrades**		***Sarah's* Upgrades**	
Recharge Time:  	**Recharge:** ● 8 Hours ○ 4 Hours ○ 2 Hours ○ 1 Hour	**Recharge Time:**  	**Recharge:** ○ 8 Hours ○ 4 Hours ○ 2 Hours ● 1 Hour
Electric Mode:  All Electric **For the First 10 Miles**	**Electric:** ○ Type #1 ○ Type #2 ○ Type #3 ● Type #4 **Distance:** ● 10 miles ○ 20 miles ○ 40 miles	**Electric Mode:**  Electric Assist **For the First 40 Miles**	**Electric:** ○ Type #1 ● Type #2 ○ Type #3 ○ Type #4 **Distance:** ○ 10 miles ○ 20 miles ● 40 miles
Gasoline Mode:  **37 MPG**	**Gasoline:** ● +10 MPG ○ +20 MPG ○ +30 MPG	**Gasoline Mode:**  **57 MPG**	**Gasoline:** ○ +10 MPG ○ +20 MPG ● +30 MPG

Now think about your household. Which upgrades are important? Please consult with your family to prioritize these upgrades.

Appendix H: PHEV survey part 2 (online questionnaire)

(Summarized from Axsen and Kurani, 2008)

Section 1: Recharge Opportunities

1) Over the course of your trial with the plug-in vehicle, you may have identified multiple recharge locations for your vehicle. Please list up to three recharge locations that you think you would use most if you owned a vehicle like this:

2) Now imagine that your _______ could be powered by electricity. To plug-in your vehicle, you would need to run an electrical cord from your vehicle to an electric outlet when you are parked. Complete charging could take 1 to 8 hours.

Which of the following potential problems may stop you from plugging-in your ______ at each of these locations?

We are too busy or lazy to plug in
The electric cord is a hazard.
The electric cord is vulnerable to damage.
The electric cord looks ugly.
The electrical outlet is already used by other electrical devices.
The electrical outlet might blow a fuse.
The owner of the electrical outlet doesn't want us to use their electricity.
The weather is undesirable.
We won't be parked long enough to bother.

3) Now think about the problems you just identified with each location. Also consider the benefits of using electricity, such as potential cost savings. Given the typical driving habits of your household during a given week, what is the maximum amount of time you could plug in your ________ at these locations?

Please construct a rough schedule your household might follow for an average week:

4) Would you be willing to take any of the following actions to plug-in your _______ more often?

Section 2: Designing your plug-in vehicle

Now, Imagine that you have a just won a contest to upgrade your ______ into a plug-in hybrid vehicle, allowing you to use electricity to drive, using less gasoline. This upgrade promises that everything else about your vehicle will stay the same (appearance, performance, safety, warranty, etc.).

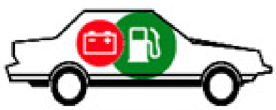
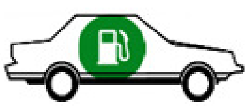
First We Need to Know...

1) What is the average fuel economy of your ________ in miles per gallon (MPG)?

Now you have the opportunity to upgrade your vehicle. You can upgrade your plug-in vehicle in four different ways, as described in Your Plug-In Vehicle Guide. Please consult this document for explanations if you need help.

Each upgrade requires a certain number of “points.” We want to know what upgrades you consider to be most important. You will be shown 5 scenarios. Each scenario will give you a different number of “points” to make upgrades. Each scenario is independent, so you can choose different upgrades each time.

Scenario #1:
If you have X points to make an upgrade, how would you use it?
Please be realistic. Consider how your household uses this vehicle, and where you have access to electrical outlets, if at all (from your plug-in diary).

Your Plug-In Hybrid MINI COOPER	Upgrades	Upgrades Points
Recharge Time:  8 Hours required to fully recharge vehicle.	**Time to Fully Recharge:** (●) 8 Hours ( ) 4 Hours (1 pt) ( ) 2 Hours (2 pts) ( ) 1 Hours (3 pts)	**Total Points: 6 pts** **Points Used: 0 pts** **Points Left: 6 pts**
↓		
Electric Mode:  75 MPG Electric Assist For the First 10 Miles	**Electric Capability:** (●) Type #1: Electric Assist (75 MPG) ( ) Type #2: Electric Assist (100 MPG) (1 pt) ( ) Type #3: Electric Assist (125 MPG) (2 pts) ( ) Type #4: All Electric (4 pts) **Distance With Electric Capability:** (●) First 10 Miles ( ) First 20 Miles (1 pt) ( ) First 40 Miles (2 pt)	
↓		
Gasoline Mode:  38 MPG Gasoline Only Until Recharged	**Gasoline Use:** (●) 38 Miles Per Gallon ( ) 48 Miles Per Gallon (1 pt) ( ) 58 Miles Per Gallon (2 pt)	

Description of Your Choice:
The above vehicle takes 8 Hours to recharge. When fully recharged, it can be driven for the First 40 miles in Type #4: All Electric mode. After this distance, it can only be driven in gasoline mode until recharged, getting 38 Miles Per Gallon

Section 3: Next Vehicle Purchase

This section will present a game to simulate your household's next new vehicle purchase. First, we ask several questions about your household's intentions.

1) Which of the following statements best summarizes your household's plans to purchase your next new vehicle?

2) How soon do you believe your household will buy or lease its next new vehicle?

3) Which of the following best describes your next vehicle purchase?

4) When your household buys or leases its next new vehicle, which of the following descriptions best describes the vehicle type you will likely choose?

5) For this last section, we will refer to the type of vehicle your household will likely buy or lease next. Please select a make and model that best describes your next vehicle. If you are unsure, you can simply select your current vehicle.

From here on, we assume that your household's next vehicle purchase will be a new ______.

6) About how much do you think your household will spend to buy this ________?

7) What do you think will be the approximate fuel economy (Miles Per Gallon - MPG) of this _________ you will buy?

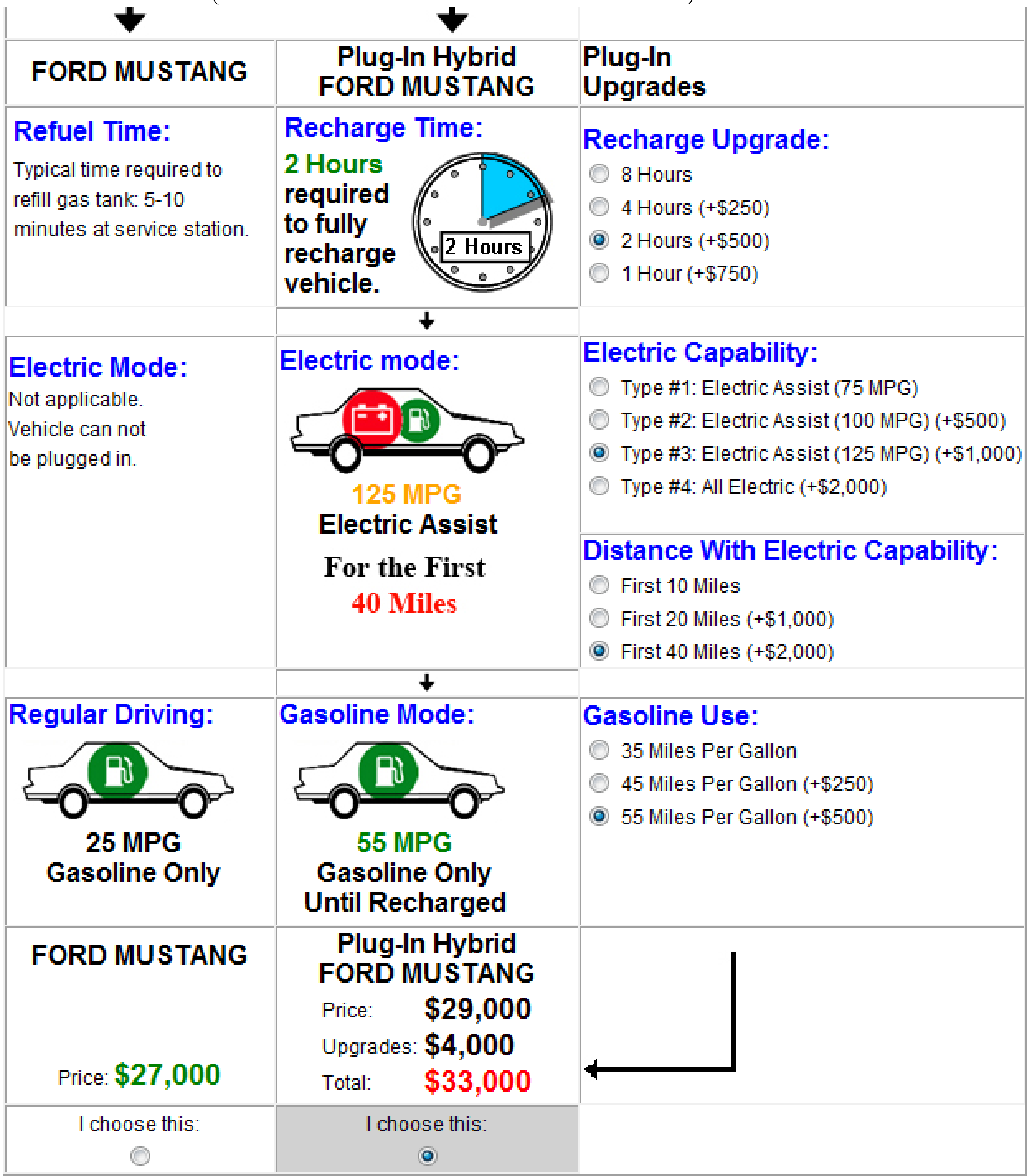
You will be shown 3 scenarios. Each scenario you will show you different prices for the plug-in hybrid options and upgrades. Each scenario is independent, so you can choose different vehicles or upgrades each time.

You can customize the specific features of the plug-in version, just as you did in the previous exercise. Again, refer to Your Plug-In Vehicle Guide for help in choosing upgrades, particularly the summary on pages 7 to 8.

Given the two options below, which would your household likely purchase?

Other than the price, the plug-in feature, and fuel consumption, every other characteristic of the two vehicles are identical. In other words, the plug-in version of the ________ has the same body, performance, interior size, etc. as the regular __________.

Price Scenario #1 (Low Cost Scenario – Order Randomized)



FORD MUSTANG	Plug-In Hybrid FORD MUSTANG	Plug-In Upgrades
Refuel Time: Typical time required to refill gas tank: 5-10 minutes at service station.	**Recharge Time:** 2 Hours required to fully recharge vehicle. (2 Hours)	**Recharge Upgrade:** ○ 8 Hours ○ 4 Hours (+$250) ● 2 Hours (+$500) ○ 1 Hour (+$750)
Electric Mode: Not applicable. Vehicle can not be plugged in.	**Electric mode:** 125 MPG Electric Assist For the First 40 Miles	**Electric Capability:** ○ Type #1: Electric Assist (75 MPG) ○ Type #2: Electric Assist (100 MPG) (+$500) ● Type #3: Electric Assist (125 MPG) (+$1,000) ○ Type #4: All Electric (+$2,000) **Distance With Electric Capability:** ○ First 10 Miles ○ First 20 Miles (+$1,000) ● First 40 Miles (+$2,000)
Regular Driving: 25 MPG Gasoline Only	**Gasoline Mode:** 55 MPG Gasoline Only Until Recharged	**Gasoline Use:** ○ 35 Miles Per Gallon ○ 45 Miles Per Gallon (+$250) ● 55 Miles Per Gallon (+$500)
FORD MUSTANG Price: $27,000	Plug-In Hybrid FORD MUSTANG Price: $29,000 Upgrades: $4,000 Total: $33,000	
I choose this: ○	I choose this: ●	

11) Did you consult anyone from your household when you completed the previous plug-in vehicle design exercises (or prepared to complete them)?
12) Which of the following statements best summarizes your experiences in designing your plug-in vehicle in this survey?
You chose a plug-in hybrid vehicle in certain price scenarios.
13) Which of the following reasons most encouraged you to choose a plug-in hybrid vehicle for you next purchase?
14) From what you know about this technology now, please indicate your level of agreement with the following statements:

> "My household could save a lot of money with this plug-in technology."
> "My household would find it very difficult to find electric outlets to plug in such a vehicle."
> "This plug-in technology will not fix any environmental problems, even if everyone in the US drove one."
> "Overall, this plug-in technology is a bad idea."
> "The next time my household buys a new vehicle, we would pay extra for a vehicle with this plug-in technology."

Appendix I: Closing interview questionnaire (outline)

Part 1: Experiences with the vehicle (~1 hour)
(Adapted from Ken Kurani)

1. Why did you want to participate in this research?
1.1 Expectations, hopes and concerns?
1.2 How were expectations met and/or disappointed?

2. Driving patterns
2.1 Who drive the vehicle? How was this decided?
2.2 Tell me about driving the PHEV. What did you like? What didn't you like
2.3 Did your travel change for the month?
2.4 Could you tell when the vehicle was operating on electricity only? How?
Was this important to you? Why, or why not?
2.5 Did you change your driving? In response to what? How? Why?

3. Energy use instrumentation
3.1 Did you use it? Which screens? Which information?

4. Recharging
4.1 Was it easy or difficult? A convenience or a hassle?
4.2 Can you imagine yourself doing recharging a vehicle over the long-term? Why?
4.3 Would you change anything about your parking or access to electricity to improve recharging?
4.4 Did you recharge away from your home? Why?
- Were these casual or essential? What were you trying to accomplish?

5 . Did you notice changes (from your household's own vehicles) in gasoline refueling, e.g., frequency, location, and cost?

6. Energy use
6.1 Did you track both electricity and gasoline use and cost? How?
6.2 Was the V2Green website useful, interesting? How much did you use it?
6.3 Were you able to determine whether the PHEV "saved you money"?
6.4 Would this be important to you, or would other things motivate you to drive a PHEV?
- What are these other things?
- How would you assess if you were getting enough of them to motivate you to drive a PHEV?

7. Review questionnaire answers
7.1 Save $21 in gas or electricity question: why did you choose your answer?
7.2 PHEV design games: Why did you answer the way they did?
- did you read the guide?
- was the game understandable?
- what did "all-electric" mean to you?

- why did they create the designs they did?
- did the game seem to get at what they thought would be important to them about PHEVs?
- what other feature or capability would they add?

7.3 Would you say you would be more motivated to drive a PHEV that operated on electricity-only as much as possible or by a PHEV that had high fuel economy while operating on gasoline?
7.4 What are your ideas about both these possibilities? What strikes you as interesting and valuable?
7.5 How would you choose between them?

8. Summary of benefits/disbenefits of PHEV
8.1 Restate elicited benefits – why are these important?
8.2 Restate elicited disbenefits – why are these important?
8.3 Does a vehicle say something about its owner? SUV owners? What about a PHEV like this?

Part II: Social Episode diary (~1 hour)
(Selected parts adapted from Carrasco et al., 2007)

1. Social episode diary
1.1 Did you complete the diary? Did you miss any episodes?
- if incomplete, try to construct episodes now

1.2 Do you feel you talked with people a lot about PHEVs or vehicle technology in general? More or less than expected?
1.3 Which episodes did you initiate?
1.4 Which episode(s) stand out most to you? Why?
1.5 Were two or more of these episodes linked? (Like an ongoing conversation or debate?)

2. Detail several episodes, including:
2.1 Situational details:
- when (time of day, day of week, duration
- where (detail spatial location)
- who was involved (already identified from personal network?)
- was the episode planned? How did it start?
- what was the topic of discussion?
- who said what about the PHEV (or vehicle technology)

2.2 What do you think the other person (people) thought about the episode? Did they learn something or shift their perspective in any way?
2.3 What did you think about the episode? Did you learn something or change your perspective in any?
2.4 Describe any episodes that you feel had a strong influence on the other participants. How?
2.5 Describe any episodes that you feel had a strong influence on you. How?

3. Re-visiting your personal network

3.1 Would you change anything now to update or adapt this network to better reflect reality? Any new contacts or links?
3.2 Which of these people (sub-networks) were you in contact with during the PHEV trial? Why did you talk to some and not others about the PHEV?
3.3 Are there some people (sub-network) that you wish you had spoken with? Or you think you would contact in a longer time frame? Why? What would you say?
3.4 Which people would (sub-networks) would you most want to contact:
- to seek advice about such technology?
- to offer advice about such technology?
- to show the vehicle to?
- to generally discuss the vehicle?

4. Future vehicle purchase intention
4.1 When do you anticipate next vehicle purchase?
4.2 Details:
- new or used?
- replace an existing car or add to fleet?
- potential models?
- HEV or alternative vehicle considered?

4.3 Sources of information for this intention
4.4 Will you consult someone from your personal network?
4.5 What additional sources of information might you consult before purchase?
4.6 What are the most important benefits/disbenefits you hope to get from you next vehicle purchase?
4.7 What do you hope this vehicle will say about you?

Appendix J: Experience Ranking Exercise

Equipment:

"Experience generator" instrument:

- two piece of paper (8.5 x 11 inches)
- 80 Post-it Ultra page markers (cut in half lengthwise), 40 yellow on one piece of paper, 40 pink on the other

"Influence ranker":

- Single sheet of paper (22 x 17 inches) with a continuum depicted lengthwise, from "most influential experiences" at the top to "least influential experiences" at the bottom
- Bulletin board backdrop (about 23 x 16 inches of cork)

Interview protocol

Explaining the rationale for this exercise to respondents:
"The overall goals of this study are to allow you to assess this PHEV and to learn from you how such a vehicle may or may not fit into your life. As a final exercise, we would like you to think about all the experiences you had over the last month, and to think about how influential each experience was in regards to your overall assessment of this PHEV technology. In other words, which experiences had the most impact, and which had the least?"

How influential was each experience in <u>your overall assessment</u> of this plug-in hybrid technology (PHEV).

Which experiences had the most impact, and which had the least?

1. Generating experience list

1.1 Prepared list:

- prior to the final interviewer, researchers will have prepared a list of experiences elicited from previous interviews, surveys and other points of contacts
- each experience is summarized in a few words on a post-it note
- as much as possible, use the respondents' own words
- human-based experiences are listed on yellow notes
- thing-based experiences are listed on pink notes

(some experiences may fit both categories, but we'll just do our best)

1.2 Additional experiences:

- during the first portion of the final interview, the researcher will need to add experiences as they come up (without disrupting the flow of the interview)

1.3 Respondent additions:

- throughout the process, invite the respondent to add experiences, which may simply be rewordings or components of already listed experiences

2. Ranking experiences

- ask respondent to place each experience on the “influence ranker,” more influential experiences are placed higher, and less influential experiences are placed lower
- place yellow notes (human-based experiences) on the left side of the line, and pink notes (thing-based experiences) on the right side
- remind respondent that they can keep moving around the stickers until they are satisfied

3. Summary

- does depiction look satisfyingly accurate? Do you need to add or remove anything?
- would you need to add any experiences that occurred prior to the 30-day trial?

Example of experience list

With the PHEV	**With UCD researchers**	**With others**
Interacting with the car during the initial test-drive	Reading the invitation letter	Talking with Z
Interacting with the Prius feedback screens	Receiving the initial phone call	Etc.
Driving to work	Talking with X and Y at interview #1	
Driving to golf	Talking with X and Y during the initial test-drive	
Driving to run errands	Completing part 1 of survey	
Driving during other trips	Visiting the V2green website	
Plugging in at home	Completing the vehicle discussion diary	
Plugging in at work	Talking with X at interview #2	
Plugging in at X’s house	Reading the PHEV buyers’ guide	
Looking at MPG ratings	Completing part 2 of survey	
Watching the battery deplete	Talking with X and Y at interview #3	
Refueling the car		

Appendix K: Additional Survey Questions for Secondary Participants

(Added to the beginning of part one.)

First, we'd like you to tell us how you found out about this survey.

At UC Davis, we are trying to learn more about how people interact with plug-in hybrid vehicles. As one part of our study, we are giving plug-in hybrid vehicles to different households in Northern California—these household gets to try out the vehicle for several weeks. We also want to talk to the people that these households come into contact with, such as you.

One of our participants has invited you to complete this survey.

1) Please provide this person's first name:

☐ Click here if you have no idea

If you don't know this person's name, please describe something about them that could help figure out who it is:

2) In terms of a social relationship, how close are you to **BILLY**?

○ I am very close to **BILLY**
(I discuss important matter with **BILLY**, or I regularly keep in touch with **BILLY**, or **BILLY** is there for me if I need help.)

◉ I am somewhat close to **BILLY**
(**BILLY** is closer than a casual acquaintance, but not very close)

○ I am a casual acquaintance with **BILLY**
(I come into contact with **BILLY** sometimes, but we are not close)

○ **BILLY** is a stranger

Next

3) Please describe how you know this person. Use as much detail as you can.
Include details of how you first met, how often you currently contact each other, if you are both affiliated with the same group, club, workplace, neighborhood etc..

Think back to when **BILLY** invited you to this survey.

4) What was the form of communication?

- In person (face to face)
- By phone (landline, cellular or internet-based)
- In handwriting (mail, note, etc.)
- By email
- By another form of electronic communication (instant message, text message, blog, myspace, facebook, etc.)

5) Where were you when you first received this invitation?
Please describe in a sentence or two.

6) In as much detail as possible, please summarize everything that BILLY told you about the UC Davis study and the plug-in hybrid vehicle:

(Added to the end of part two.)

Section 5: Contact with Participants

At the beginning of Part 1 of this survey, you described how **BILLY** invited you to take part in this survey**.**

1) Since your invitation, how many times have you been in contact with **BILLY**?
By contact, we mean in person, by phone, mail, e-mail, online chat, or any other form of communication.
Please do not include the initial invitation.

Since the invitation I have…

- …not been in contact with **BILLY.**
- …been in contact with **BILLY** ____ times.

2) Please indicate how many times you used the following forms of communication with **BILLY** since your initial invitation to the survey?
Please do not include the initial invitation.

Enter 0 if you did not use a particular form of communication.

In person (face to face)	☐ times.
By phone (home, cell, etc.)	☐ times.
In handwriting (mail, note, etc.)	☐ times.
By email	☐ times.
Other electronic communication (instant message, text, blog, facebook, etc.)	☐ times.

3) How many times did you *discuss the plug-in hybrid vehicle* with **BILLY** by each form of communication, since your initial invitation?
Please do not include the initial invitation.
Enter 0 if you did not use a particular form of communication.

In person (face to face)	☐ times.
By phone (home, cell, etc.)	☐ times.
In handwriting (mail, note, etc.)	☐ times.
By email	☐ times.
Other electronic communication (instant message, text, blog, facebook, etc.)	☐ times.

4) Please describe your communications with **BILLY** in as much detail as you can.
Please do not include the initial invitation.
Please include approximations of time, location, and duration of communication, who initiated, who was involved, and what was said.

5) Since the initial invitation, did you ask **BILLY** any questions about the plug-in hybrid vehicle?
Please do not include the initial invitation.

☐ Yes

☐ No

Please list as many of your questions as you can remember:
(If you have already provided these details, write "see previous question.")

6) Since the initial invitation, did **BILLY** tell you anything about the plug-in hybrid vehicle?
Please do not include the initial invitation.

- [ ] Yes
- [ ] No

Please list as much information as you can remember:
(If you have already provided these details, write "see previous question.")

7) Overall, what did you learn about plug-in hybrid vehicles from your contact with **BILLY**?

In this online survey, you have had several opportunities to *assess* plug-in hybrid vehicle technology, such as what kind of vehicle you might want, and how it may or may not fit into your lifestyle.

8) How *influential* was **BILLY** in your overall assessment of plug-in hybrid vehicles?

BILLY was…

- [ ] …highly influential in my assessment.
- [ ] …somewhat influential in my assessment.
- [ ] …not influential in my assessment.

Appendix L: Phone Interview for Secondary Participants

Phone Interview for Secondary Respondents

Confirm the name of secondary respondent, explain the interview procedures, and attain verbal consent before proceeding. Follow this script for consent:

Study Summary: Researchers at the University of California, Davis are interested in consumer responses to vehicles that run on different kinds of energy and fuels. Currently, we are placing plug-in hybrid vehicles into households in the greater Sacramento area. You have met one of these households. In this phone interview, we would like to ask you some questions about your experience with this household, as well as your perceptions about plug-in hybrid vehicles. The interview will not exceed 30 minutes.

Benefits: By participating, you will be helping us to better understand the needs of drivers in the U.S. As a token of our gratitude, we will mail you a $20 gift card upon completion of the interview (in addition to whatever rewards you have already earned).

Your Rights:
You may refuse to participate in this interview.
You may change your mind about being in the interview and quit after the interview has started.
You have the right not to answer a specific question, but still proceed with the interview.
You are allowed to ask any questions concerning the interview, both before agreeing to be involved and during the course of the interview.

Confidentiality: This interview will be recorded. Collected data will be kept confidential on password protected, secure servers at the UC Davis campus. Absolute confidentiality cannot be guaranteed, since research documents are not protected from subpoena.

Interviewers of secondary respondents must sign below to indicate that the above information has been communicated to the secondary respondent, and that the secondary respondent has agreed to proceed with the phone interview.

____
Interviewer's signature

Begin survey protocol:

1) In terms of a social relationship, how close are you to this person?
- I am very close
(I discuss important matters, or regularly keep in touch, or are there for me if I need help.)
- I am somewhat close
(closer than a casual acquaintance, but not very close)
- I am a casual acquaintance
(come into contact sometimes, but we are not close)
- Strangers

2) Please describe how you know this person. Use as much detail as you can.
Include details of how you first met, how often you currently contact each other, if you are both affiliated with the same group, club, workplace, neighborhood etc.

3) What was the form of communication?
In person (face to face), By phone (landline, cellular or internet-based), In handwriting (mail, note, etc.), By email, By another form of electronic communication (instant message, text message, blog, myspace, facebook, etc.)

4) Where were you when you first received this invitation?

5) In as much detail as possible, please summarize everything that they told you about the UC Davis study and the plug-in hybrid vehicle.

6) Who initiated the discussion?

7) What did you say to them?

8) Did you see/drive in/interact with the vehicle? If yes, what was that like? If no, why not? Did you want to?

9) In your opinion, what do you think is the big idea about plug-in hybrid vehicles? Is anything is important about them? Is anything exciting? Could you imagine yourself buying one?

10) Did your discussions with this person change your perceptions or feelings about plug-in hybrid vehicles, or alternative fuel vehicles in general? How? Or why not?

11) Have you talked to this person since? How often? Did you discuss the vehicle or technology?

12) Were other people involved in any of these discussions? How many? Who? What did they say?

13) Since talking with this person, have you told any other people about plug-in hybrid vehicles, or the UC davis study? What did you say? What did they say? Do you think they were interested?

14) In the survey design game, why did you design the vehicle you did?

15) Why would anybody buy this kind of vehicle? Why would you? Has your response to this question changed since your experience with the UC Davis PHEV?