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A Grounded Agent Model of the Consumer Technology Adoption Process

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A GROUNDED AGENT MODEL OF THE CONSUMER TECHNOLOGY ADOPTION PROCESS

by

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DISSERTATION APPROVAL

The abstract and dissertation of Brent Alan Zenobia for the Doctor of Philosophy in Systems Science: Engineering Management were presented June 2, 2008, and accepted by the dissertation committee and the doctoral program.

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ABSTRACT

An abstract of the dissertation of Brent Alan Zenobia for the Doctor of Philosophy in Systems Science: Engineering Management presented June 2, 2008.

Title: A Grounded Agent Model of the Consumer Technology Adoption Process

Adoption is one of the most important concepts in the diffusion of innovations (DOI) literature, yet certain aspects of it are poorly understood. In particular, causal adoption process theory (CAPT) has been stagnant for decades and seldom subjected to critical scrutiny. In consequence, DOI research is unstable – different studies identify different factors as important.

This dissertation introduces grounded agent modeling, a hybrid methodology drawing on existing software engineering and social science techniques to construct a step-by-step explanation of how consumers make technology adoption decisions. Inductive case studies, grounded theory, and sequence analysis are used to investigate transportation mode adoption and build a theoretical framework that is sufficiently precise to guide its implementation in Unified Modeling Language (UML).

What emerges is the Motive-Technology-Belief (MTB) framework, a theory that conceptualizes adoption in terms of motives (inner mental reasons), technologies (tools that pertain to motives) and beliefs (associations between motives and/or technologies.) Motives and technologies are self-similar and exhibit fractal structure.

The atomic unit of adoption is the *temor*, a belief that associates a technology with a particular motive.

Three conscious processes govern the behavior of these structures. "Selecting" chooses a tool to satisfy an immediate need. "Evaluating" constructs beliefs about a tool. Selecting and evaluating are complementary *ceteris paribus* processes that operate in tandem. "Maintaining" determines the functional status of a tool. Five unconscious auxiliary processes – "perceiving," "framing," "focusing," "categorizing," and "acting" – govern motivation.

This study makes important contributions to several fields by cracking open two black boxes – one theoretical, the other methodological. The theoretical contribution is a coherent and empirically grounded framework that exposes the inner mental processes of adoption. The methodological contribution is to combine qualitative field research with UML to make consumer agent modeling more systematic, clear, and insightful. The substantive contribution is a grounded agent model that is well-suited to guide the construction of simulated consumer agents. Aggregations of calibrated consumer agents may be able to identify new markets before they exist and model DOI with greater accuracy. Consequently, this dissertation lays the foundation for a totally new approach to research on DOI and the formation of markets.

DEDICATION

To my husband Jason, who made it possible.

"I find it difficult to share the enthusiasm of some writers for the application of complexity theory to organizational phenomena, precisely because the specific explanatory mechanisms behind its application are often not specified. The general but banal insight that organizational processes involve opposing forces, nonlinear relationships, and feedback loops needs fleshing out. One interesting point raised by these theorists, however, is that the interaction of a relatively small number of simple deterministic elements may generate complexity, if they take into account such phenomena. With this, there is hope that relatively parsimonious theoretical formulations may be able to make sense of the complexity observed in process data." (Langley, 1999, pg. 694)

"The profession [of software engineering] has not fully realized the epistemological implications of its own work. Eventually someone will come and explain what lessons the experience of software construction holds for the intellectual world at large. No doubt abstract data types will figure prominently in the list." (Meyer, 1997, pg. 148)

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Particular thanks to my family, *Arthur*, *Donna*, and *Duncan Saffir* for their emotional support – to say nothing of the use of Arthur's copier!

Finally, my deepest love and appreciation to my husband *Jason Zenobia*, whose steadfast support and assistance sustained me through the ups and downs of pursuing my lifelong dream.

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GLOSSARY

ABSS ..... Agent-Based Social Simulation
AM ..... Artificial Market
CAPT ..... Causal Adoption Process Theory
CAVT ..... Causal Adoption Variance Theory
CBAM ..... Concerns-Based Adoption Model
CIT ..... Critical Incident Technique
DD ..... Decision Diagram
DOI ..... Diffusion of Innovations
GAM ..... Grounded Agent Model
GT ..... Grounded Theory
MOT ..... Management of Technology
MTB ..... Motive-Technology-Belief
PP+ ..... Passport Plus
SD ..... System Dynamics
TADP ..... Technology Adoption Decision Process
TTM ..... Transtheoretical Model
UML ..... Unified Modeling Language
WB ..... Winter Bikes

NOTATION SUMMARY

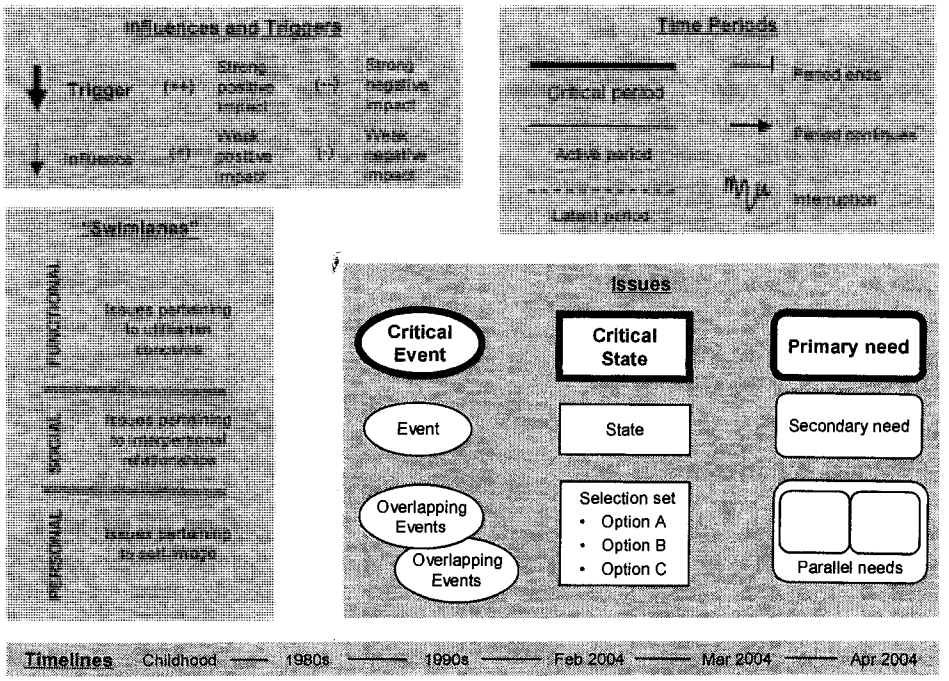


Figure 1. Decision Diagram Notation

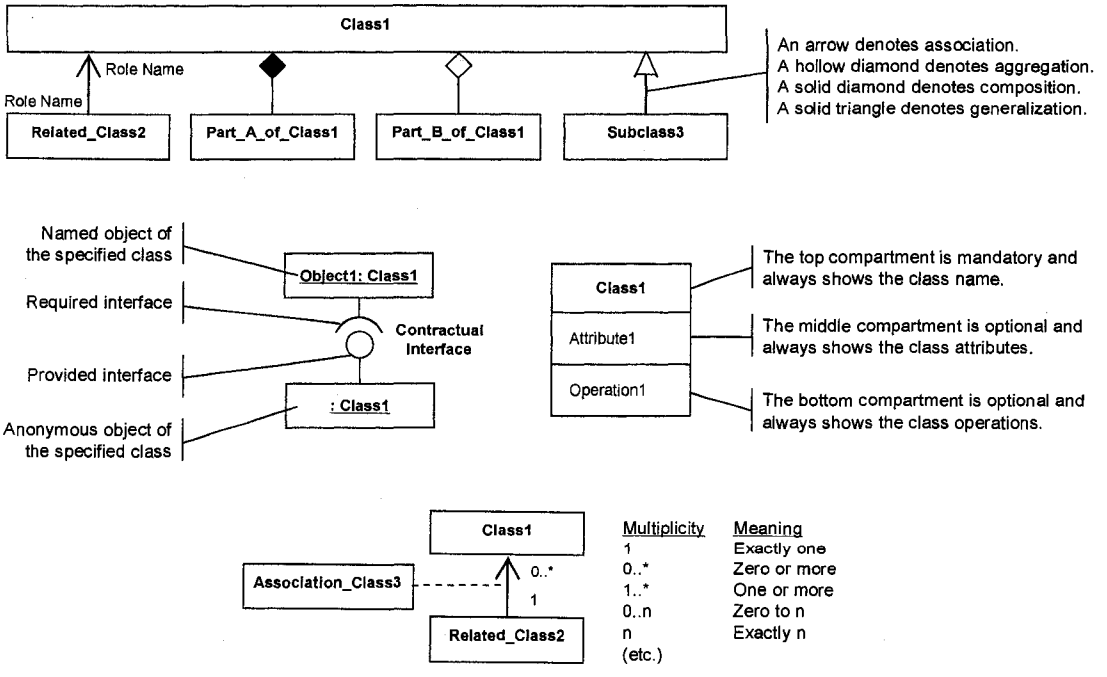


Figure 2. UML Class Diagram Notation

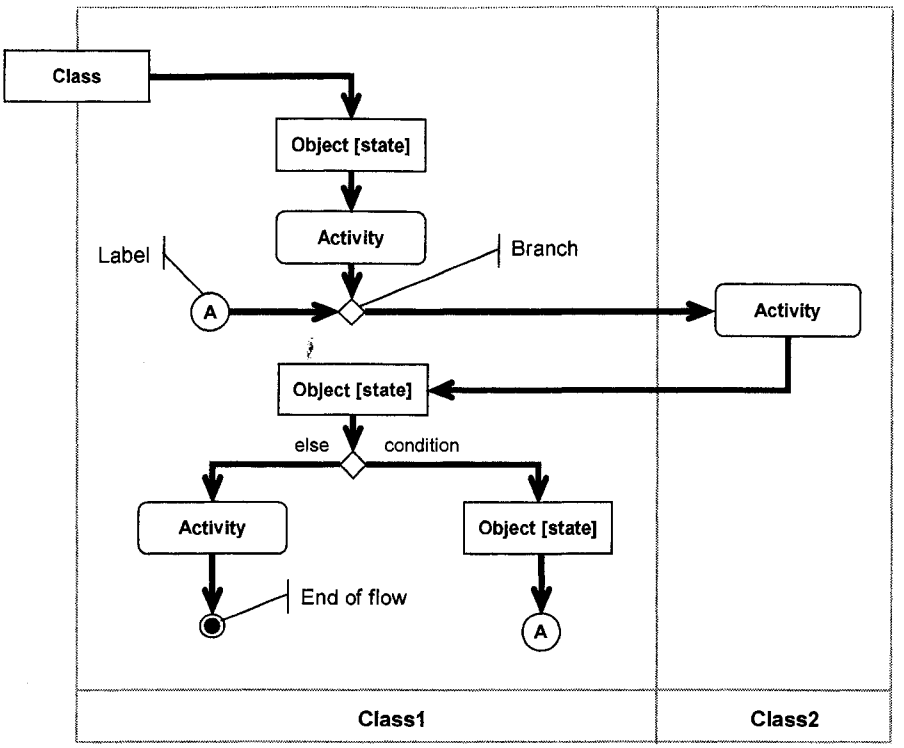


Figure 3. UML Activity Diagram Notation

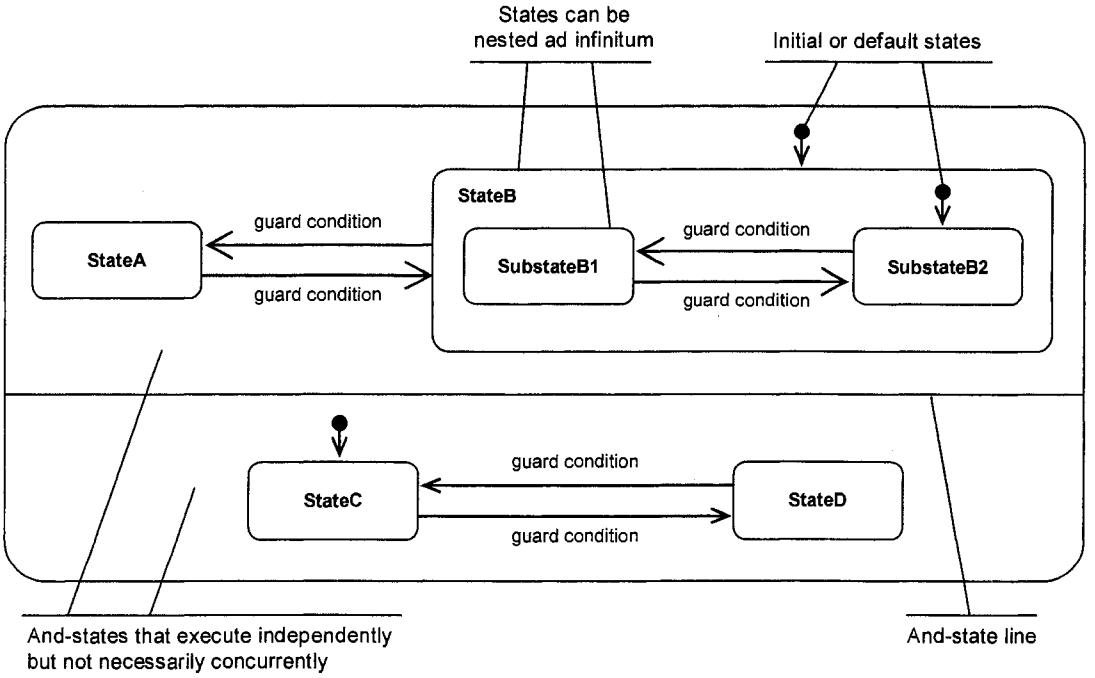


Figure 4. UML Statechart Notation

CHAPTER 1. PROBLEM, OBJECTIVES, AND OVERVIEW

1.1. The Need for New Adoption Theory

Adoption is the process of finding the right tool for the job. It is one of the oldest and most important concepts in the diffusion of innovations literature (Eveland, 1979) and has been the focus of a mammoth body of research (Choudrie & Dwivedi, 2005; Venkatesh, 2006). To convey some idea of the size of this literature, one popular questionnaire for measuring organizational adoption, the Technology Acceptance Model (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989), has well over a thousand citations; even more widely cited is the Transtheoretical Model (Prochaska & DiClemente, 1984), a questionnaire used to measure the adoption of health-related innovations by individuals. The literature is so large that one might conclude that there could be no remaining gaps which could justify undertaking yet another adoption study.

And yet, despite this abundant literature, there is still much about adoption that is poorly understood. To be sure, certain aspects are quite mature, such as the identification of factors influencing adoption rates or outcomes for various innovations. However, causal adoption process theory (CAPT) has been stagnant for decades and has seldom been subjected to much critical examination or scrutiny (Eveland, 1979; Mohr, 1982; Gatignon & Robertson, 1985; Venkatesh, 2006). A CAPT is a step-by-step explanation of how events or life experiences cause beliefs about a technology to change over time.

Everett Rogers argues that past adoption studies have been theoretically shallow, displaying "a kind of sameness, as they pursue a small number of research issues with somewhat stereotyped approaches" (Rogers, 2003, pg. 40). Historically, consumer adoption studies have tended to rely almost exclusively on surveys, while organizational adoption studies have nearly always utilized case studies (Choudrie & Dwivedi, 2005). For Elihu Katz (1999, pg. 145), the stagnation of CAPT is attributable in part to the multidisciplinary nature of adoption: "Almost nobody admits to owning the problem, and the state of the theory shows it." The result has been 'miles of studies – inches of theory.' Rogers adds that "students of diffusion have been working where the ground is soft...The challenge for future research is to expand the area of digging and to search for different objectives than those of the past. Perhaps there is a need to dig deeper, in directions that theory suggests." (Rogers, 2003, pg. 101)

One may be tempted to ask: "So what if adoption studies are theoretically shallow? Doesn't this vast body of literature imply that CAPT isn't essential to adoption practice?" The answer is that theory *is* important, for several reasons: it provides a framework for identifying empirical patterns and resolving inconsistencies across studies; it helps recommend directions for future research; it generates hypotheses by which generalizable conclusions may be tested; it locates research within the broader context of knowledge claims; and it serves as a mechanism for integrating knowledge from related fields (Steinfield & Fulk, 1990).

The stagnation of CAPT also has practical consequences, for it contributes to the instability of diffusion research. Downs and Mohr define instability as a tendency for one study to identify factors which are considered important to diffusion, only to have these same factors found to be less important, unimportant, or inversely important by other diffusion studies (Downs & Mohr, 1976, pg. 700). This instability is caused in part by variation in how adoption is conceptualized, measured, and compared:

> "For example, a positive relation between the social status of the potential adopter and earliness of adoption is supported in 275 studies (68 percent) and not supported in 127 others. Why is that? [...] The world is complex; it is not surprising that sometimes older managers are the first to innovate and sometimes younger ones. What one cannot do is make any theoretical sense out of such a record. Moreover, it cannot be productive, at this point, to add either the 276th supporting study or the 128th nonsupporting study to the running tally on social status and innovation." (Mohr, 1982, pg. 8)

As a purely practical matter, then, the stagnation of CAPT makes it difficult to identify which aspects of adoption are significant and stable enough to measure.

1.2. The Management Question

CAPT does not merely study tool *use*; its focus is the broader mental and social process of *sensemaking* about tools within the context of one's life. CAPT does not seek to explain adoption in technology-centric terms such as the number of units sold or the frequency of use; neither does it seek to explain adoption by treating collective entities (e.g., groups, teams, coalitions, business units, departments, organizations, or industries) as if they were discrete causal actors (Whitehead, 1929/1978; Sandelands & Stablein, 1987; Drazin & Sandelands, 1992; Anderson,

1999). CAPT identifies *individuals* as the agents who cause adoption outcomes to circulate, reproduce, and persist over time within collective entities (Schank, 2001).

However, management of technology (MOT) is primarily concerned with collective social phenomena such as diffusion, organizational learning and strategy, innovation dynamics, technology markets, and so forth. How could a CAPT of individual consumer adoption help MOT practitioners to extract useful information from organizations, technology markets or innovations, or predict their future behavior? The answer is: by harnessing agent-based social simulation as a new tool for market research.

1.3. Artificial Markets

A CAPT may be built, tested, and validated with empirical field research, but its full potential can only be unleashed through computer simulation. Over the past decade it has become possible to construct agent-based simulations of actual cities, regions, and even whole countries that are geographically and demographically accurate to a spatial resolution of a few meters. By adding agents to simulate the actions and interactions of individual consumers, a new and extremely powerful form of simulation may be constructed with the power to revolutionize MOT research: an *artificial market* (AM).

Consumer agents are the "sim-citizens" of an AM. Agents are programmed to simulate the behavior and communication of real consumers, in proportions which reflect the demographics and preferences of actual markets. Agents of various types may be combined within the same AM, such as firms pursuing various strategies (e.g.,

invention, innovation, imitation, reaction) to increase market share among the simulated consumers. "The resulting society will – unavoidably – couple demography, economics, cultural change, conflict, and public health. All these spheres of social life will emerge – and merge – naturally and without top-down specification, from the purely local interactions of the individual agents." (Epstein & Axtell, 1996, pg. 158)

Together with their cousins, artificial organizations (Prietula, Carley, & Gasser, 1998), AMs could facilitate understanding and insight and make possible new practical applications such as generating and evaluating new business models for disruptive markets, profiling products and services that markets are poised to accept, exploring innovation dynamics, forecasting technology diffusion, and much more.

Consumer agent modeling is embryonic, but a need has already emerged for a CAPT of consumer adoption that is 1) solidly grounded in empirical observations of consumer behavior and 2) sufficiently precise and formal to guide the construction of simulated consumer agents (Kottonau, Burse, & Pahl-Wostl, 2000; Ben Said, Drogoul, & Bouron, 2002; Klüver, Stoica, & Schmidt, 2003; Zhang & Zhang, 2007). Computers are unforgiving of ambiguity, and unfortunately most extant behavioral theories are too imprecise and informal to serve as a reliable guide for consumer agent construction (Goldspink, 2002).

1.4. Dissertation Objectives

To summarize, the stagnation of CAPT contributes to instability in diffusion research and hinders the development of AMs as a new venue for MOT research.

CAPT is needed that is solidly grounded in empirical observations of consumer behavior and sufficiently precise and formal to guide the construction of simulated consumer agents.

The objective of this study is to build a CAPT to explain how certain events or life experiences change a consumer's beliefs about technologies over time. Two sets of research questions are posed:

RQ-1. *How do consumers make adoption decisions?* What are the characteristic states and events of the process? Which transition patterns are observed to occur? How do consumers limit the time and effort they expend on the process? How do they respond to interruptions? How is the adoption process bounded in time?

RQ-2. *How might a grounded agent model (GAM) be constructed from empirical evidence?* How might its structure and behavior be derived from *in situ* observations?

To address these questions, theory-building methods from the social sciences (inductive case studies, grounded theory, and sequence analysis) are applied in conjunction with software engineering modeling techniques to construct a theoretical framework for adoption that is sufficiently precise and formal to be expressed as a GAM in Unified Modeling Language (UML). The aim of this study is to construct a 'simulation-ready' theory of adoption (as opposed to an actual working simulation.)

The substantive topic is the psychological process by which transportation consumers adopt single occupancy vehicles alternatives such as transit, bicycles, and

car sharing. Two cases are examined. The first is a retrospective study of transportation mode adoption among participants in Portland State University's Passport Plus program, an annual pass which entitles the bearer to the use of light rail, bus, car sharing, and reduced rate campus parking in any desired combination. The objective of the first case is to unpack the properties and dimensions of adoption by investigating how participants in this program make choices and tradeoffs from among the available options. The second case is a longitudinal cohort study of novice winter bicycle commuters; its objective is to trace the progression of the adoption process over time and identify its characteristic states, events, and transition sequences.

This study should be understood as the first project in a long-term research program. After completion of this study, the next phase will be to use the GAM as a measurement model for a questionnaire to classify the adoption status of consumers. After validating the questionnaire (and, by extension, the GAM), the final phase will integrate the GAM as a component of an agent-based AM simulation.

1.5. Dissertation Overview

This dissertation is organized into ten chapters. The second chapter reviews the theoretical and methodological literature on technology adoption; it concludes that adoption is a reified concept which is in need of fresh theoretical perspectives. Chapter three examines the potential of "Artificial Markets as a New Venue for Innovation Research" and finds that new methodologies are needed that can synthesize social science field research and software engineering modeling techniques to produce grounded agent models of consumer behavior. Chapter four introduces a methodology

for constructing behavioral agents from qualitative field research; this chapter presents an overview of the research approach and discusses steps taken during the data collection process. The nature of the grounded theory discovery is such that greater clarity may be attained by discussing methodology and data collection in the same chapter.

Chapters five through eight are devoted to data analysis. Chapter five presents an overview of the theoretical framework, followed by detailed analysis of the "Structural Foundations" in chapter six, "Conscious Behavioral Processes" in chapter seven, and "Unconscious Auxiliary Processes" in chapter eight.

The ninth chapter discusses steps taken to ensure the "Validity and Generalizability" of the framework. The tenth and final chapter, "Conclusions" reviews the findings of the study, discusses its contributions and limitations, and recommends directions for future research.

CHAPTER 2. LITERATURE REVIEW

2.1. The Adoption Concept

Adoption is one of the oldest and most important concepts in the diffusion of innovations (DOI) literature (Eveland, 1979). Although it is central to DOI research, the concept is slippery and elusive. 'Adoption' and 'innovation' are often used interchangeably in DOI research, especially in the organizational context (e.g., Downs & Mohr, 1976; Rogers, 2003, Chapter 10). A certain conceptual overlap exists among 'adoption', 'learning', 'problem solving', 'decision making', and 'innovation'. Adoption can refer to a process, an event, or a state of being – sometimes all at once. Adoption is laden with positive value and implied finality; adopters are those who adopt, as opposed to rejectors who decide not to adopt, or nonadopters who have yet to begin the process of becoming adopters.

Eveland (1979) argues that DOI researchers have tended to reify adoption, legitimizing the concept through frequent repetition without pausing to critically consider its deeper implications. He recommended that DOI researchers observe a moratorium on the use of 'adoption' until the concept could be more clearly defined, but his advice was unheeded. Adoption has served as the main dependent variable for a large number of DOI studies and has provided the main basis for the generalizability claims of most DOI research (Eveland, 1979; Tornatzky & Klein, 1982). It has also served as an important criterion for measuring the effectiveness of prescriptive diffusion campaigns (e.g., Vaughan & Rogers, 2000; Polacsek et al., 2001). By

contrast, adoption's antithesis rejection has been the stepchild of DOI research, receiving relatively scant attention and funding.

Rogers (2003, pg. 21) defines adoption as the decision to make full use of an innovation as the best course of action available. He distinguishes among three types of adoption decisions:

- An *optional* adoption decision is made by a single individual (e.g., most consumer decisions).
- A *collective* adoption decision is arrived at through group consensus.
- An *authority* adoption decision is imposed by a relatively few individuals who occupy positions of power, status, or technical expertise in a group.

Most MOT research on diffusion has investigated collective or authority adoption decisions in organizational settings. This study focuses on optional adoption decisions, which are 'optional' in the sense that the final decision to implement or reject is made by a single individual. However, 'optional' does not imply that the individual acts as a free agent, since family, friends, salespersons, and advertising can still apply social pressure to adopt or not to adopt (Katz, 1962). Adoption is an inherently social process.

2.2. Adoption Process Models

The *technology adoption decision process* (TADP) is a dynamic sequence of actions and interactions by which an individual evaluates a technological innovation

and decides whether to incorporate it into ongoing practice. The dominant assumption of most TADP models is the phase theorem (Witte, 1972), which states that decision making occurs in sequential phases or stages – presumably because the cognitive aspects of adoption are easier to manage if the process is broken into more manageable subtasks.

The most frequently cited adoption model in the DOI literature is the Rogers model (Figure 5) whose five stages have served as the dependent variable for a sizable number of studies (Ettlie, 1980).

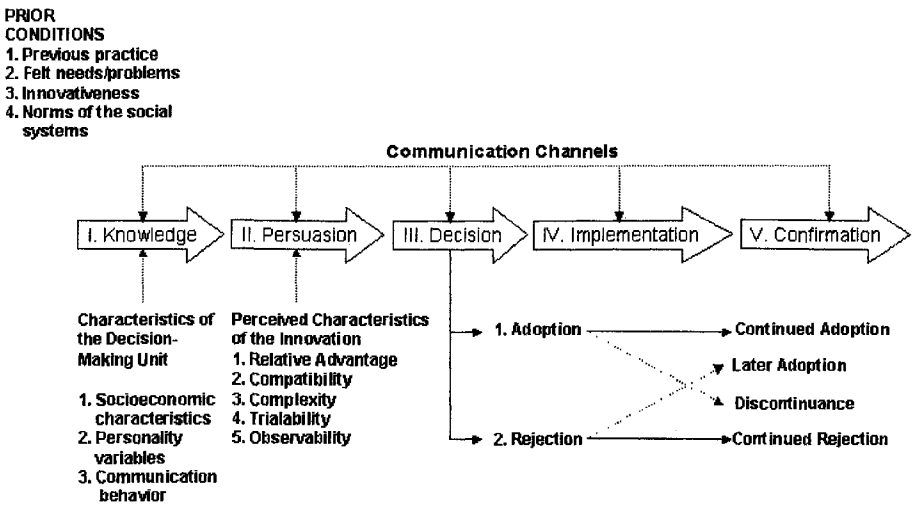


Figure 5. The Rogers Model of the TADP (Rogers, 2003)

Several other staged TADP models have appeared over the years. Some have addressed innovation adoption decisions made by individuals (Lavidge & Steiner, 1961; Rogers, 1962; Klongan & Coward, 1970; Robertson, 1971; Rogers & Shoemaker, 1971; Zaltman & Brooker, 1971). Others have explored the TADP in organizational or collective settings (e.g., Cyert & March, 1963; Mintzberg, Raisinghani, & Théorêt, 1976; Eveland, Rogers, & Klepper, 1977; Nutt, 1984; Meyer

& Goes, 1988; Langley & Truax, 1994), for specific classes of innovations (e.g., Wildemuth, 1992), or by substage (e.g., Pounds, 1969; Alexander, 1979; Lyles & Mitroff, 1980; Dutton, Fahey, & Narayanan, 1983; Smith, 1989).

Staged models are also common in the consumer psychology literature, where they have been used to describe behavior change by individuals (e.g., Janis & Mann, 1977, pg. 171-200; Montgomery, 1983; Prochaska, DiClemente, & Norcross, 1992; Beach & Mitchell, 1996; McGuire, 2001) as well as problem-solving by individuals (e.g., Polya, 1957; Simon, 1960; Brim, Glass, Lavin, & Goodman, 1962; Newell & Simon, 1963; Maier, 1964; Pounds, 1969; Newell & Simon, 1972; Kast & Rosenzweig, 1979; Bransford & Stein, 1984).

In the marketing literature the most widely-cited TADP model is probably the Engel-Blackwell-Miniard model (1982), shown in Figure 6.

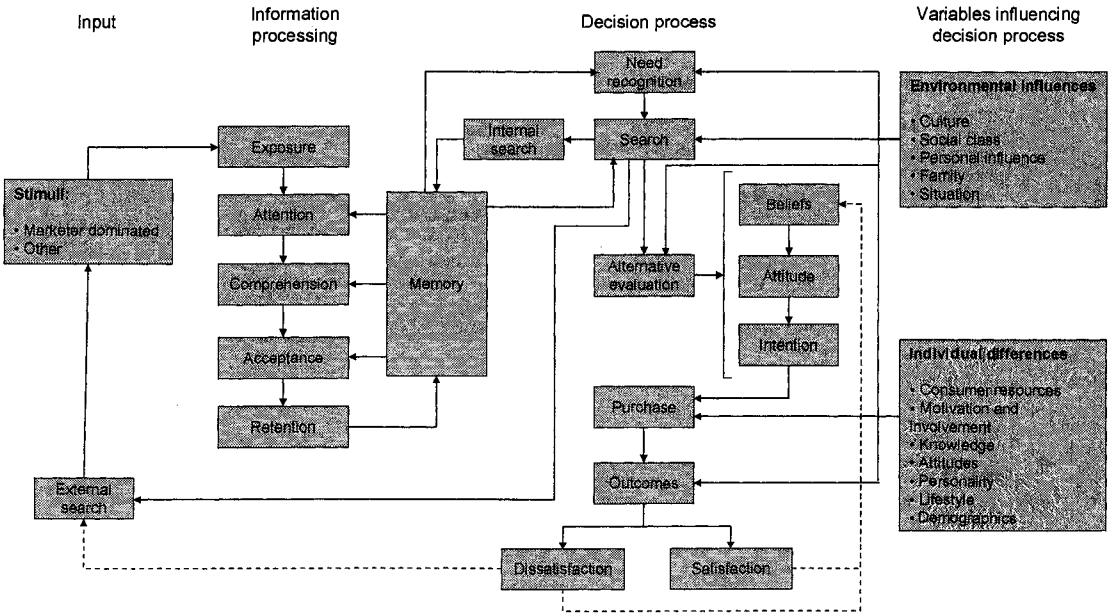


Figure 6. The Engel-Blackwell-Miniard Model of Consumer Behavior (Loudon & Della Bitta, 1993)

2.3. Criticisms of Adoption Process Models

The empirical validity of staged models remains in doubt. Only a handful of studies have tested the validity of staged TADP models (Ettlie, 1980; Lipshitz & Bar-Ilan, 1996; Rogers, 2003, pp. 197-198). In a study of the adoption of 34 transportation innovations from six firms, Ettlie (1980) found that the Rogers model adequately described the decision making sequence about 60% of the time. Several researchers report evidence of overlap between stages, difficulty in clearly distinguishing between stages, skipped stages, and out-of-order stages (e.g., Beal & Rogers, 1960; Francis & Rogers, 1960; Mason, 1962; Sabherwal & Robey, 1993; Langley & Truax, 1994; Langley, Mintzberg, Pitcher, Posada, & Saint-Macary, 1995; Tucker, 1999; Rosen, 2000). Other studies report truncated search procedures (Cyert & March, 1963), interruptions and disjointed progress (Braybrooke & Lindblom, 1963; Mintzberg et al., 1976), and coincidental confluence of problems, solutions, decision makers and choice opportunities (March & Olsen, 1976).

Most staged models offer little in the way of theoretical justification (Ettlie, 1980; Gatignon & Robertson, 1991; Lipshitz & Bar-Ilan, 1996; Rogers, 2003, pp. 197-198). The theoretical basis of the Rogers model is the tendency of individuals to seek information from different communication channels during different stages of the adoption process (Beal, Rogers, & Bohlen, 1957). However, this is a weak basis for differentiating stages, since individuals may use the same information channels in each stage (Bach, 1989; Rogers, 2003, pg. 197) and non-stage processes may be responsible for the differences (Weinstein, Rothman, & Sutton, 1998). Furthermore,

this criterion is inherently biased since interview questions about information sources and communication channels tend to be framed in terms of an implicit stage model (Mason, 1962; Poole & Roth, 1989). In some cases these stages may derive more from the researcher's logic than empirical observations of events over time (Sabherwal & Robey, 1993). In other cases stage models may be constructed on the basis of retrospective interviews, which tends to bias the models because informants may selectively recall details which make the decision process seem more sequential and logical than it appeared at the time (Coughenour, 1965; Schwenk, 1985). Nutt concludes that "the sequence of problem definition, alternative generation, refinement, and selection, called for by nearly every theorist, seems rooted in rational arguments, not behavior." (Nutt, 1984, pg. 446)

Staged decision making models share a certain degree of conceptual overlap and privilege the stages of the process over events or turning points. Most depict transition paths as simple linear sequences with little consideration of branching, exceptions, interrupts, parallelism, or iteration; or, these features may be discussed in general terms while the exact circumstances of their occurrence is left unspecified. Almost without exception, staged models grossly simplify adoption behavior and are too informal to permit the formulation of testable propositions and falsifiable hypotheses. Since the reliability of most staged models is problematic, it is difficult to assess their validity.

In summary, the TADP occupies a pivotal role in DOI research (Eveland, 1979; Rogers, 2003, pp. 196-197). Many staged TADP models have been proposed,

but they tend to privilege the stages of the process over other aspects such as critical events or transition paths. Stages are often emphasized when facilitating communication is the goal. The first models of the TADP were developed as teaching tools (Hassinger, 1959) with lasting consequences for how the TADP has been approached in the literature. Staged models are most applicable to preprogrammed decisions, arrived at by individual decision makers, acting with deliberate intent to consider the adoption of innovations embodied by fixed-form physical products. They are least applicable to non-routine strategic decisions, arrived at by organizational or collective decision making units, with regard to loosely-structured innovations, about which no clearly agreed-upon goal or consensus exists (Meyer & Goes, 1988, pg. 902; Abbott, 1990).

2.4. Bias in Adoption Process Research

The DOI literature is heavily tilted toward prescriptive research, giving rise to systematic shortcomings which limit what is understood about the TADP (Gatignon & Robertson, 1985; Rogers, 2003). Pro-innovation bias is the assumption that an innovation should be adopted as widely as possible without deviating from endorsed patterns of use (Rogers, 2003, pg. 106). This form of bias has caused certain aspects of the TADP to be under-researched, such as the rejection and discontinuance of innovations, user modification of innovations, and user motivations for adoption (von Hippel, 1976, 2005). "If diffusion scholars could more adequately see an innovation through the eyes of their respondents, including why the innovation was adopted or

rejected, diffusion research would be in a better position to shed the pro-innovation bias of the past." (Rogers, 2003, pg. 116).

A second form of shortcoming is source bias, which Rogers (pg. 118) defines as:

> "...a tendency for diffusion research to side with the change agencies that promote innovations rather than with the individuals who are potential adopters. This source bias is perhaps suggested by the words that we use to describe this field of research: 'diffusion' research might have been called something like 'problem solving,' 'innovation seeking,' or 'evaluation of innovations' had the audience originally been a stronger influence on the research...The source sponsorship of early diffusion studies may have given these investigations not only a pro-innovation bias but also structured the nature of diffusion research in other important ways."

In many DOI studies adoption is defined as the purchase or acquisition of whichever innovation is centrally valued by the research sponsor (Eveland, 1979). Researchers who take this stance tend to frame adoption as a question of *whether* to accept a proffered innovation rather than *which* of several competing options to choose.

Rogers also argues that DOI scholars sometimes overlook the ethical issues raised by their research. He advocates taking an "empirical-critical" stance which explicitly considers the ethical considerations of research while at the same time affirms the value of empirical scientific inquiry (Rogers, 1987).

In summary, there is a prescriptive flavor to most DOI literature on adoption. Descriptive research is needed to stimulate the development of new diffusion theory,

investigate the TADP from the decision maker's perspective, and avoid the source bias and pro-innovation bias which pervades DOI research.

2.5. Consumer Adoption

Consumer research is a multidisciplinary area whose main contributions have come from psychology, marketing, and economics. It overlaps the DOI literature to some extent and shares several key contributors (e.g., Everett M. Rogers, Gerald Zaltman, Thomas Robertson, Hubert Gatignon, Richard Bagozzi, R.H. Thaler). The roots of consumer behavioral research are in marketing, and many self-identified consumer psychologists now work in marketing departments (Ölander, 1993). An economics thread weaves its way through this literature, although consumer psychologists far outnumber economic psychologists (Lea & Belk, 1994).

Consumers have been a traditional focus for basic behavioral research. In an analysis of studies published in the *Journal of Consumer Research*, Lutz (1991) found that the majority of consumer research designs begin in the conceptual domain to identify a theory of interest, then move to the methodological domain to devise a test of that theory, and finally proceed to the substantive domain to identify phenomena which fit the theoretical boundary conditions. Lutz argues that such 'concept-driven' research designs are unlikely to provide insight into the substantive phenomenon which is the ostensible target of the study. Ölander (1993) agrees and adds that most academic consumer psychology studies have the character of basic research, which seeks to explain theoretical and behavioral concepts, rather than applied research which contributes to knowledge about substantive phenomena. In concept-driven

research designs the choice of a substantive topic area is determined by the choices made in the theoretical and methodological domains.

Social marketing uses marketing strategy to encourage the adoption of nonprofit products and services (e.g., mass transit, recycling, conservation.) These situations are fertile grounds for basic behavioral research:

> "It can be hypothesized that social marketing situations are of such high involvement that models which are difficult to test in traditional marketing settings will reveal themselves in the more highly charged social marketing contexts. In social marketing, one is asking parents to begin to regulate family size or a rural mother to regularly weigh her child and expose the fact that her family has little food. This is a much more serious issue for the target audience than asking them to buy a Toyota or new furniture. As a consequence, when behavior change does take place, one would expect it to be driven by very powerful, relatively easily discernable forces. Underlying linkages between attitudes, personality, lifestyle, memory, external influences, and behavioral intentions ought to be relatively stronger and more stable than is the case in the less involving choices where chance influences and/or basic structural instabilities can effectively mask the underlying true relationships." (Andreasen, 1991, pg. 487)

2.6. Philosophical and Theoretical Frameworks for TADP Research

Deciding whether to adopt or reject a new innovation is a dynamic social process. Mapping the structure of the adoption process requires a different research approach than identifying factors which influence adoption. Mohr (1982) defined *process research* as a collection of methods for investigating how social organization evolves over time. Process research focuses on the structure of a social process rather than independent variables which might influence that process or dependent variables which might be influenced by that process. Process research is often defined in terms

of *events*, or discrete, measurable occurrences in time. Events provide the means by which a process may be measured, studied, modeled, and sometimes managed.

By contrast, *variance research* seeks to identify correlations or covariances among variables rather than their time order. Mohr and Rogers argue that the static nature of variance research is ill-suited to the investigation of dynamic patterns such as the movement over time from state A to state B:

> In order to explore the nature of a process, one needs a dynamic perspective to explain the causes and sequences of a series of events over time. Data-gathering methods for process research are less structured and might entail using in-depth personal interviews. The data are typically more qualitative in nature than in variance research. Seldom are statistical methods used to analyze the data in process research. Diffusion scholars have frequently failed to recognize the important distinction between variance and process research in the past (Mohr, 1978). Research on a topic such as the [TADP] should be quite different from the variance research that has predominated in the diffusion field. The scarcity of process research on the [TADP] is a basic reason why we lack definitive understanding of the degree to which stages exist. (Rogers, 2003, pp. 196-7)

One of the most important works in the TADP literature is Mohr's Explaining Organizational Behavior (1982). In this book Mohr called for increased use of process research as an alternative to variance research to remedy the instability of DOI research as well as to overcome obstacles to explanatory theory. Explaining Organizational Behavior has been widely influential and is cited by many of the studies discussed in this section.

'Process' is an overloaded term which is applicable to a wide range of phenomena. Van de Ven (1992) recommends that process researchers clarify what they mean by 'process' to establish a firm conceptual foundation, to help guide

research design choices, and to locate their research within the context of the literature.

A major theme in the DOI literature has been to understand how the TADP unfolds in organizational settings. Organizational decision making is seldom rational (Nutt, 1984, pg. 446; Meyer & Goes, 1988; Wildemuth, 1992, pg. 222). Sometimes it exhibits a clear structure, while at other times it more closely resembles a chaotic muddle. Loosely speaking, organizational decision making studies tend to cluster along a continuum between two opposing theoretical poles (Pinfield, 1986; Langley et al., 1995). Anchoring one pole is the *structured perspective*, which conceives of the organizational decision making as a structured sequence of events gradually converging toward a resolution (e.g., Mintzberg et al., 1976). At the other pole is the *anarchic perspective*, which conceives of the TADP as the dynamic interaction of problems, solutions, participants, and choice opportunities (e.g., Cohen, March, & Olsen, 1972; Pettigrew, 1990b).

2.6.1. The Structured Perspective

The exemplar for the structured perspective is Mintzberg, Raisinghani and Théorêt's classic 1976 case study of 25 'unstructured' decision processes (Figure 7). Mintzberg and his colleagues developed a general model of the organizational decision process in enough detail to be represented in flow chart form. It is more complete than many staged models, featuring path cycles, time delays, and interrupts.

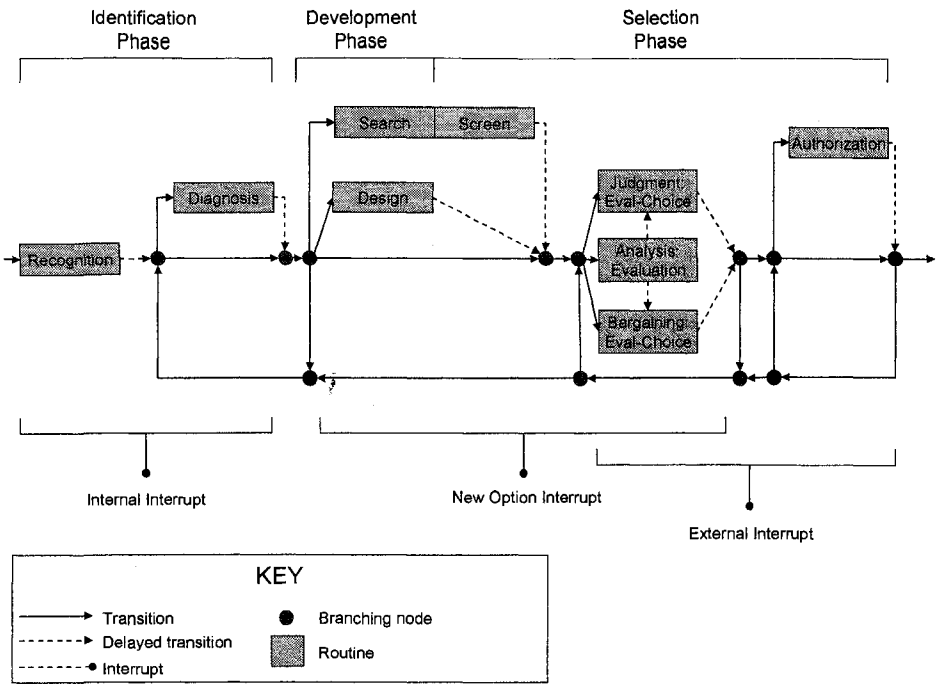


Figure 7. The Mintzberg-Raisinghani-Théorêt Model of Decision Making (Mintzberg et al., 1976)

Early structured perspective research defined the TADP as a 'pattern in a stream of decisions' (Mintzberg, 1978; Mintzberg, 1979). However, when theorists attempted to backtrace the evolution of any particular decision, they found it difficult to pin down exactly when decisions were made in organizations (e.g., Meyer, 1991; Langley & Truax, 1994). Scholars have disagreed as to why 'the decision' is so elusive. Some have framed the issue in operational terms: most strategic decisions leave few measurable traces. Others have cited the bounded perspective of individual informants (Meyer, 1991) and known problems with the reliability of retrospective interviewing techniques (Coughenour, 1965; Schwenk, 1985). Some have questioned whether 'the decision' is a meaningful construct in an organizational setting (Mintzberg & Waters, 1990; Pettigrew, 1990b; Langley & Truax, 1994; Langley et al., 1995). As one GM executive remarked,

> "It is often difficult to say who decided something and when – or even who originated a decision...I frequently don't know when a decision is made in General Motors. I don't remember being in a committee meeting when things came to a vote. Usually someone will simply summarize a developing position. Everyone else either nods or states his particular terms of consensus." (Quoted in Quinn, 1980, pg. 134)

2.6.2. The Anarchic Perspective

At the opposing pole is the *anarchic perspective*, exemplified by Cohen, March and Olsen's 'garbage can' model of decision making in universities. Cohen and colleagues (Cohen et al., 1972, pg. 16) describe the garbage can as

> "a model of decision making in organized anarchies, that is, in situations which do not meet the conditions for more classical models of decision making in some or all of three important ways: preferences are problematic, technology is unclear, or participation is fluid. The garbage can process is one in which problems, solutions, and participants move from one choice opportunity to another in such a way that the nature of the choice, the time it takes, and the problems it solves all depend on a relatively complicated intermeshing of elements. These include the mix of choices available at any one time, the mix of problems that have access to the organization, the mix of solutions looking for problems, and the outside demands of the decision makers."

Scholars sharing the anarchic perspective insist on "explicit recognition that change is multifaceted; involving political, cultural, incremental, environmental, and structural, as well as rational dimensions. Power, chance, opportunism, accident are as influential in shaping outcomes as are design, negotiated agreements and master-plans" (Pettigrew, 1990a, pg. 268). A major contribution of this perspective is that it shuns the notion of 'decisions' as artificial, *post facto* constructs imposed by researchers and onlookers in their attempt to make sense of an inherently dynamic, fluid social process. Another contribution is that it explicitly acknowledges the key element of social interaction in the decision making process.

A strong 'anti-pattern' thread weaves its way through anarchic perspective research, perhaps in reaction to the presumed rationality and top-down design implicit in structured perspective research. Langley and her colleagues (1995) along with Pinfield (1986) believe that the anarchic perspective exaggerates the extent of disorder in organizational decision making, since hierarchies very often do provide sufficient constraint on goals, actions, and participants for structured patterns of decision making to emerge.

The anarchic perspective has made only limited theoretical contributions to organizational research. In part, this may be so because the anarchic perspective does not easily lend itself to follow up by instrumental research; any unexplained variance in organization strategy formation can always be dumped into the "garbage can of organizational chaos" (Pinfield, 1986). The anarchic perspective seeks to develop rich historical narratives which preserve the context and antecedents of organizational change; for practical reasons, this usually limits data collection to a single case, making it difficult to generalize or make theoretical sense of the findings. The anarchic perspective remains a minority view among organizational theorists (Langley et al., 1995, pg. 262) but it has been relatively more influential among sociologists (Carley, 1995, pg. 7). Pinfield (1986, pg. 367) compares and contrasts the structured and anarchic perspectives (Table 1).

TABLE 1. THE STRUCTURED AND ANARCHIC PERSPECTIVES (PINFIELD, 1986)

Attribute	Structured (e.g., Mintzberg et al., 1976)	Anarchic (Cohen et al., 1972)
Decision definition	1. The decision process is defined retrospectively beginning with a commitment to action. 2. Decision processes have clear endings and implicitly clear beginnings. 3. Sequences of activities are interpreted in terms of their functional contribution to the resolution of a problem.	1. "Decisions" are a post-factum constructs produced by participants or onlookers. 2. The origins and terminations of decision processes are problematic. 3. Problems can be addressed without any explicit consideration of whether a choice is being made. Choices can be made without any explicit consideration of whether a problem is being solved.
Goals and technology	1. Participants agree on goals. 2. Participants disagree about how best to accomplish those goals	1. Participants disagree about goals. 2. Participants disagree about the best way to accomplish those goals.
Participation	No explicit consideration of participant makeup.	1. Participation is fluid. 2. Participants are important as carriers of problems and solutions.
Contextual dependence	No explicit consideration of the decision making context.	1. Patterns of decisions are influenced by concurrent problems, alternative choice opportunities, and participant attention. 2. Random, exogenous events influence problem definition and evaluation criteria.
Time	1. Different moments in time can be considered functionally equivalent. 2. Identification, development, and selection occur in rough sequence.	1. The past cannot be repeated. Passage of time permits problem and contextual evolution and influences evaluation criteria. 2. There is no necessary sequence to problems, choices, and actions.

2.6.3. Alternative Perspectives

Langley, Mintzberg, and colleagues (1995) argue that the literature on organizational decision making is stuck along a continuum between the opposing poles of the structured and anarchic perspectives, inhibiting further theoretical progress. They attribute this stagnation to three fundamental factors:

- 'The decision' is a reified construct which assumes that there is a single moment of 'choice', reflecting a bias towards centralized thinking about organizations as concrete, mechanistic structures.
- Organizational theorists have largely ignored the role of the individual as the creator, carrier, and primary causal agent in collective decision episodes.
- Organizational research has tended to study decision episodes in isolation from one another as well as from their surrounding organizational context.

The structured perspective applies when there is agreement about goals; the anarchic perspective applies when goals are ambiguous, participation is fluid, and actions are diffuse (Daft, 1983; Pinfield, 1986). The structured and anarchic perspectives have staked out the macro and micro endpoints, but new perspectives are needed to bridge the gap between individual and organizational behavior by exploring complex, nonlinear meso-level phenomena.

The binary opposition of the anarchic and structured perspectives is not limited to organizational research, for it replicates a fault line which runs throughout the social sciences. Silverstein (1988) characterizes this fault line as a tension between the particular (the uniqueness of individual cases) and the universal (generic patterns transcending individual cases). Structural anthropologist Claude Lévi-Strauss argued that human classification systems are constrained to move in one of two directions: in a 'downwards' direction towards the analytic pole when the goal is to explore a rich lexicon of meaning; and in an 'upwards' direction towards the synthetic pole when the goal is to identify common patterns, construct abstractions, and develop general theories (Wiseman & Groves, 2000). Thus, the tension between the anarchic and structured perspectives does not stem from a gap in the literature; it is the product of a fundamental ontological divide.

2.7. Causal Adoption Theory

All process theories are explanatory, but not all explanatory theories are process-oriented. Even if we cannot explain the TADP itself, we would at least like to explain how the inputs influence the outcomes. Following Mohr's distinction, it is useful to divide causal adoption theories into two groups, as shown in Figure 8: causal adoption variance theories (CAVT) and causal adoption process theories (CAPT). CAPTs explain causality in terms of the internal structure and behavior of the TADP, but they do not predict how the inputs influence the outputs. CAVTs explain causality between inputs and outcomes, but treat the process itself as a black box whose internal details are neither observed nor explained.

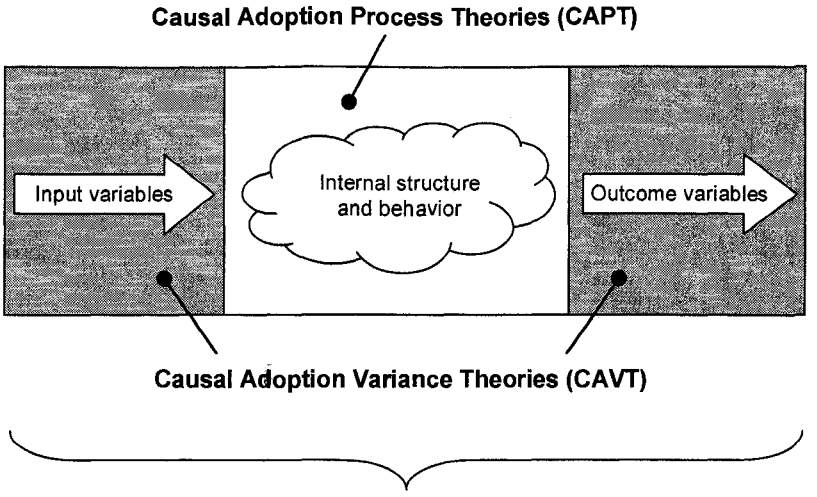


Figure 8. CAPT and CAVT in Relation to the TADP

One popular and useful CAVT technique is LISREL (Jöreskog, 1970), a multivariate modeling method in which the researcher treats the process as a *construct*: an approximation of a concept that can be defined, but not directly measured (e.g., motivations, feelings, and attitudes.) On the basis of these constructs, the modeler specifies a set of causal relationships by which one or more input variables are hypothesized to cause or create outcomes represented by at least one other variable. CAVT defines causation in variance terms: a sufficient degree of correlation must exist between the variables; one variable must occur before the other; and no other reasonable cause may explain the outcome. LISREL models consist of two parts. The first part is the measurement model, a set of indicators for each construct together with an assessment of their reliability. The second part is the structural model, a set of dependency relationships that link the constructs. LISREL was used to develop two widely-cited CAVTs: the Theory of Planned Behavior (Ajzen, 1985) and the Technology Acceptance Model (Davis, 1989).

LISREL is an extremely useful (if rather complicated) technique that is widely used in the social and behavioral sciences. However, CAVTs are only as good as their constructs. A structural model can be shown to have an acceptable fit, but there is no guarantee that another model would not fit at least as well. Since the constructs are almost completely specified by the researcher, it is essential for them to have some basis in CAPT to help guide the estimation process – especially when modifying the structural model. LISREL is a confirmatory method that is guided more by theory than empirical data. The structural model is very flexible, creating a significant risk that the researcher may overfit the model to the observed data or create a model with little generalizability (Hair, Anderson, Tatham, & Black, 1998). Thus, CAVT and CAPT are complementary partners. Since it is impossible to have a good CAVT without a good CAPT, the stagnation of CAPT is a serious problem for DOI research.

2.8. Methods of TADP Research

Beyond the common theme of developing explanatory theories of organizational change, scholars of the TADP have been unable to agree on a common method of inquiry. This is because they hold different views about the meaning and theory of process. They ask different questions, use different methods, and make different contributions (Van de Ven, 1992). For Van de Ven and Huber (1990), the crux of the disagreement centers on the advantages and disadvantages of:

- Identifying structural patterns vs. capturing rich historical narratives;
- Case-based vs. theory-based generalizations;

- Inductive vs. deductive theory building;
- Theory-first vs. theory-later methods of inquiry;
- Quantitative analysis of variables (CAVT) vs. qualitative exploration of events (CAPT); and
- Real-time, retrospective, or longitudinal methods of data collection.

Several traditions of inquiry were evaluated for this literature review. This discussion focuses on three: grounded theory, case studies, and sequence analysis.

2.8.1. Grounded Theory

Grounded theory (GT) is an inductive modeling method which originated in sociology (Glaser & Strauss, 1967) and subsequently became popular with management theorists (Martin & Turner, 1986; Locke, 1996, 2001; Easterby-Smith, Thorpe, & Lowe, 2002). It is best suited to the initial exploration of processes which have not previously been the subject of much systematic inquiry, or when fresh perspectives are sought.

GT occurs within a systematic and highly structured inductive framework. Data collection and analysis are closely intertwined and proceed in rounds. Data collection typically takes the form of interactive personal interviews during which the interviewer probes the informant for nuances, variations, and connections within the phenomena of interest. After each interview, *open coding*, *microanalysis*, and *theoretical memos* are used to break the data into discrete parts ("*categories*") for analysis and incorporation within a database. At this point *axial coding* is used to

uncover the attributes ("*properties*") of categories, together with the range of variability displayed by those properties ("*dimensions*"). Axial coding seeks to identify the conditions, actions/interactions, and consequences that make up the process. As new theoretical insights occur, they suggest fresh areas for inquiry and trigger additional cycles of theoretically-motivated sampling, data collection and analysis. These cycles complete when new categories cease to emerge from the data ("*saturation*"). During the final step, a *central category* is chosen to provide a framework for integration and refinement. *Selective coding* is then used to develop a story line, diagram, or other formalism to integrate and refine the categories in the axial coding model. Conditional propositions or hypotheses are typically formed at this time.

GT results in *substantive-level theory*, a low-level theory limited to a particular situation or context (Strauss & Corbin, 1990, pg. 174). Substantive-level theory stands in contrast to theories of greater abstraction and applicability termed midlevel theories, grand theories, or formal theories (Creswell, 1998, pg. 242-243). It can be problematic to generalize from a GT, although to a certain extent this drawback is common to all qualitative methods, and should be seen in the context of the tradeoff between process research and variance research. The price of using inductive theory-building techniques is that the *principle of equifinality* applies: multiple models may be equally valid in describing the behavior in question, depending on one's theoretical perspective (Van de Ven & Huber, 1990, pg. 214; Van de Ven, 1992, pg. 178).

GT is well-suited for developing process models. In the specialized language of GT, a *process* is a category with two or more stages (Glaser, 1978) or "a series of evolving sequences of action/interaction that occur over time and space, changing or sometimes remaining the same in response to the situation and context" (Strauss & Corbin, 1998, pg. 165).

GT needs a fairly large number of comparable incidents that are all richly described. Data collection and analysis can be time consuming and result in a large volume of interview transcripts. Several thousand pages are not uncommon. This technique focuses attention at such a low level of detail that it risks missing broad overall patterns operating over longer time frames. Since GT is closely bound to the interview data, is it dependent on the ability of observers and participants to recognize key events (Van de Ven & Huber, 1990, pg. 216). A GT can only be as complete as the informant's bounded knowledge, perception, and cognition allows.

2.8.1.1. Grounded Theory and the TADP.

Several authors have used the GT technique to study processes of technology adoption and organizational change. Isabella's GT analysis of shifts in the cognition of managers during episodes of organizational change received a Best Paper award from the *Academy of Management Journal* (Isabella, 1990).

Alan Meyer and colleagues used GT as part of a series of studies conducted for the National Science Foundation to model the adoption of medical equipment in community hospitals (Greer, Greer, & Meyer, 1983; Greer, 1984; Meyer, 1984; Meyer, 1985; Greer, 1986; Meyer & Goes, 1988). Over a six year period their team

conducted 355 interviews at 25 community hospitals to develop a nine stage model of the TADP, together with an associated set of measurement scales. Wildemuth (1992) used GT to construct a five-stage linear model of the TADP for end user computing applications in publishing, insurance, and health care organizations.

2.8.1.2. The Straussian and Glaserian Schools.

GT originated with the publication of The Discovery of Grounded Theory (Glaser & Strauss, 1967), a highly influential work which is still extensively cited. However, the collaboration between Barney Glaser and Anselm Strauss ended when Glaser published his Basics of Grounded Theory Analysis (1992) as a sharply critical rebuttal to Strauss and Corbin's (1990) Basics of Qualitative Research. The split between the two founders led to the emergence of different schools of GT.

The Straussian school locates agency for theory development with human researchers. The researcher plays a very active, even provocative, role to interrogate the data and develop conceptual theories. This school allows for the potential of prior theory, non-technical literature, and personal as well as professional experiences to help researchers to gain insight into the data.

The Glaserian school locates agency for theory development in neutral methods and data. Glaser argues that active provocation of the data is not only unnecessary, it actually contaminates the GT. He argues that researchers must maintain distance and independence from the phenomena under investigation and insists that the analytic techniques offered by Strauss and Corbin will preempt and obstruct understanding of the phenomena under study. Glaser believes that categories

emerge naturally from the data, and should not be forced by active provocation by the researcher. He insists that Straussian methods will result in 'forced conceptual descriptions' rather than 'grounded theories'. Glaser objects to the potential use of prior theory, non-technical literature, and personal as well as professional experiences to help researchers gain insight into the data. In his view, only the world under study should shape theorizing.

Locke notes that the primary difference between these schools concern the assumptions they make about the relationship of the researcher to the evidence (Locke, 1996, pg. 241). Locke is critical of Glaser's position that the researcher should not bring *a priori* knowledge to the research endeavor. She argues that this is a significant revision of the flexible orientation originally promoted by The Discovery of Grounded Theory, in which the authors suggested that it was possible for researchers to cultivate fruitful insights from many sources – provided that these were worked out in relation to the data. Locke believes that Glaser's verificationist views stem from his training at Columbia, where the natural world was seen as an objective reality to be discovered through objective methods ("a one-way mirror through which the natural world might be revealed", Locke, 1996, pg. 241). For Glaser, the natural world will embed itself in theory when appropriate methods are executed with discipline and restraint. "Categories emerge upon comparison and properties emerge upon more comparison. And, that is all there is to it." (Glaser, 1992, pg. 43)

Locke notes that many management scholars employing GT have simply ignored this dispute and may be unaware of its existence. She asserts that management

scholars have not kept up with developments since The Discovery of Grounded Theory and continue to cite the 1967 work without reference to any subsequent publications by either author. While these scholars claim to have followed the methods of GT, they do not provide any operational indicators and may even use procedures which run counter to the specifications of GT. Locke concludes that The Discovery of Grounded Theory is invoked by some as a kind of "methodological touchstone" which adds legitimacy to an "anything goes" approach to inductive inquiry.

2.8.1.3. The Critical Incident Technique

The critical incident technique (CIT, Flanagan, 1954) is an elicitation method used to investigate key events, incidents, processes or issues which the respondent considers to be significant. The technique is akin to GT, except that CIT allows for the existence of prior theories or conceptual frameworks to be tested or extended in the field (Chell, 1998).

CIT begins with the selection of a central category and an initial coding frame. Interviews elicit the strategy which the respondent followed to achieve a desired outcome along with the key events which took place during that process, the properties of these events, and the dimensions of the properties.

Chell describes a CIT elicitation technique in which the informant is presented with a card containing a double-headed arrow running centrally along its length. The interviewer explains that this arrowed line represents the entire period of the decision episode and its aftermath. The informant is invited to mark the significant events of the episode on the card in order of occurrence. Each event is labeled on the card, then

used as a visual reference point for reconstructing a chronology of what took place (Easterby-Smith et al., 2002, pg. 96-97). Thus, the decision episode as a whole is explored with a task-related 'grand tour' question, and the individual events are explored with 'mini-grand tour' questions (Spradley, 1979).

CIT is well-suited for the refinement of inductive process theories which are defined in terms of critical events or turning points. Miles and Huberman (1994, pg. 115) cite an example of the critical incident technique being used in conjunction with the Concerns-Based Adoption Model (CBAM, Hall, Loucks, Rutherford, & Newlove, 1975).

2.8.2. Case Studies

'Process' spans a diverse range of phenomena whose dimensions may be difficult to capture with a single case (Langley et al., 1995). Case studies examine process from multiple perspectives to gain different interpretations of decision episodes. The case study method has a long history spanning many social science disciplines including management, psychology, law, medicine, political science, anthropology, sociology and education. These disciplines employ case studies for different purposes; there is no single accepted method for conducting case study research.

A 'case' may refer to a target for inquiry (e.g., individuals, organizations, communities, decisions, projects) or a methodology for examining those targets (Miles & Huberman, 1994, pg. 25; Creswell, 1998, pg. 61). However a case is defined, there

is broad agreement that it occurs within a bounded context, and that it is a method for detailed, in-depth analysis of data collected from multiple sources.

In management research the most frequently cited methodologists are Yin (1981; 2003) and Eisenhardt (1989). Yin's approach to case studies emphasizes a quasi-experimental data collection and sampling method ('replication logic'). However, his treatment of analytical issues is relatively sparse. Eisenhardt's approach emphasizes theory building; she describes an integrative methodology which combines Yin's replication logic, Strauss and Corbin's constant comparison interviewing methods, and Miles and Huberman's analytical techniques. Her framework will be described in detail later in the chapter. Other contributors to case study research include Stake (1995), who approaches the method from the perspective of action research; Hamel and colleagues (Hamel, Dufour, & Fortin, 1993) who adopt a historical, problem-centered approach to sociological case studies; and Merriam (1988) who discusses qualitative case studies in an educational context.

The chief drawbacks with case studies involve generalizability and analysis. It is usually impractical to investigate more than a couple of dozen cases. It may be difficult to generalize from small samples, and cross-case perspectives may prove difficult to integrate; each case becomes relevant by itself, but is insufficient for understanding the outcome. Without some analytical means for integrating the perspectives, the results may be difficult to apply (Langley, 1999).

2.8.3. Sequence Analysis

Miles and Huberman agree with Mohr (1982) that the construction of explanatory process theory is a particular forté of qualitative research. Matrices may be used to develop explanatory or causal models by identifying predictor variables on the basis of similarities and patterns in chunks of coded data. Once identified, these variables may be used to make causal predictions and test emerging theoretical frameworks.

Sequence analysis maps the occurrence of critical incidents over time to identify process patterns and the interaction of process variables; it may be thought of as the analytical counterpart to the critical incident technique.

Miles and Huberman describe a suite of analytical tools for conducting sequence analysis:

- *Context charts* may be used to identify the context surrounding a decision episode (pg. 102-105).
- *Event-state networks* may be used to decompose a decision episode into a set of states and events (pg. 115-117).
- *Within-case causal network analysis* may be used to identify relationships among the set of states and events (pg. 151-165).
- *Composite sequence analysis* can be used to identify the transition sequences which link the set of states and events (pg. 204-206).

- *Causal models* may be used to generate hypotheses about the causal network (pg. 222-228).
- *Cross-case causal network analysis* may be used to devise tests of the hypotheses (pg. 228-233).

2.9. Visual Displays in TADP Research

Many qualitative TADP studies have used visual displays as a convenient way of packing a lot of information into a small space, as an analytical tool to develop and verify theoretical ideas, and as a vehicle for triangulating between case-based and variable-based analysis (Werner & Schoepfle, 1987; Tsoukas, 1989; Meyer, 1991; Langley & Truax, 1994; Miles & Huberman, 1994; Langley, 1999). Several types of visual displays have been used for this purpose. For example, Werner and Schoepfle (1987) used activity records to show the structure of hierarchical activities (Figure 9).

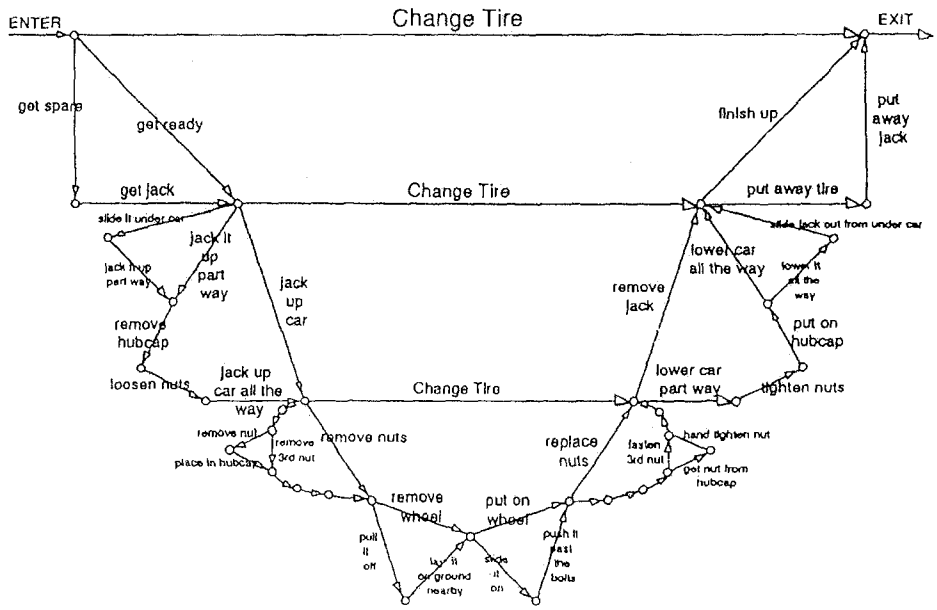


Figure 9. Example of an Activity Record (Werner & Schoepfle, 1987)

Meyer and Goes (1988) used decision models to describe the TADP for medical equipment in community hospitals (Figure 10).

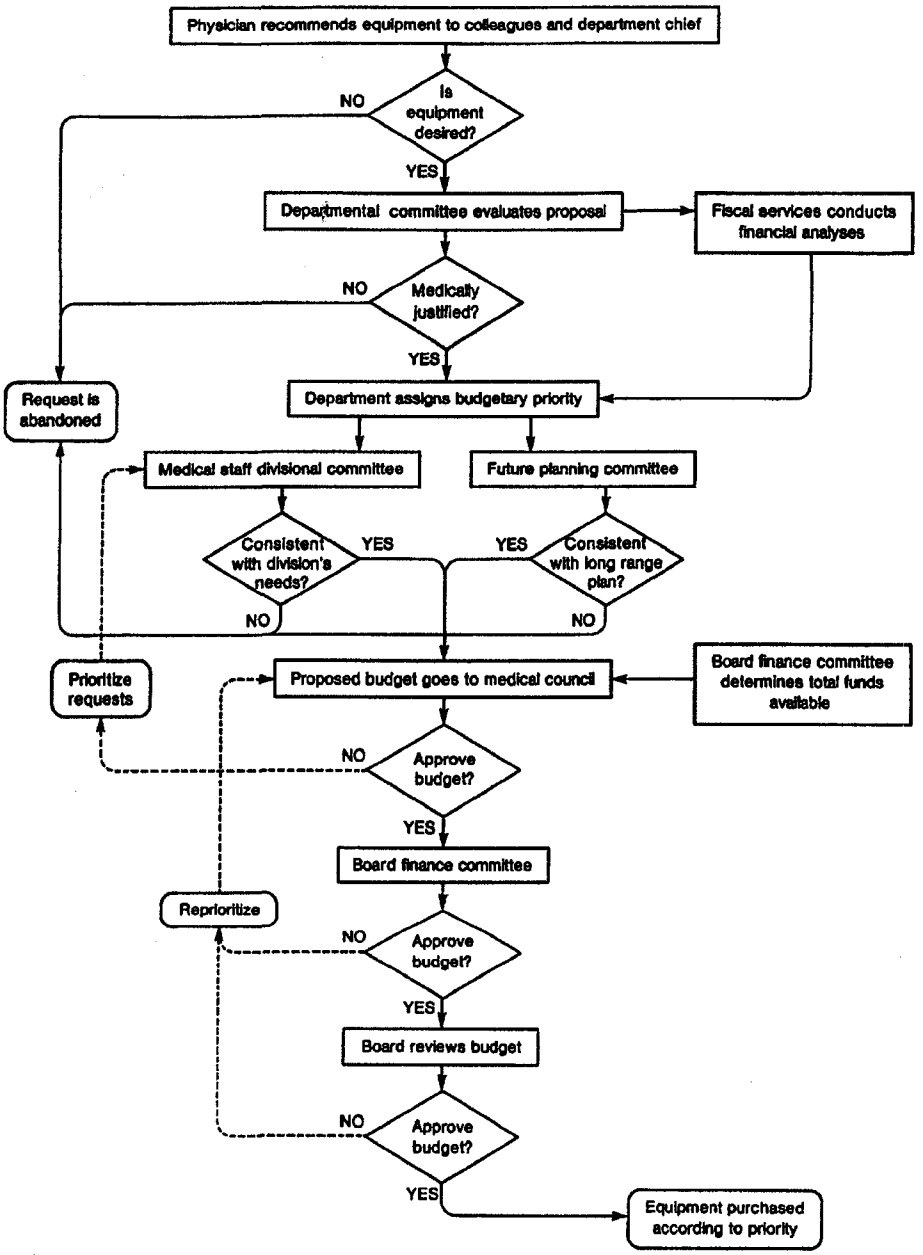


Figure 10. Example of a Decision Model (Meyer, 1991)

Langley and Truax (1994) used sequence analysis to construct an event-state network of the TADP in small manufacturing firms, as shown in Figure 11.

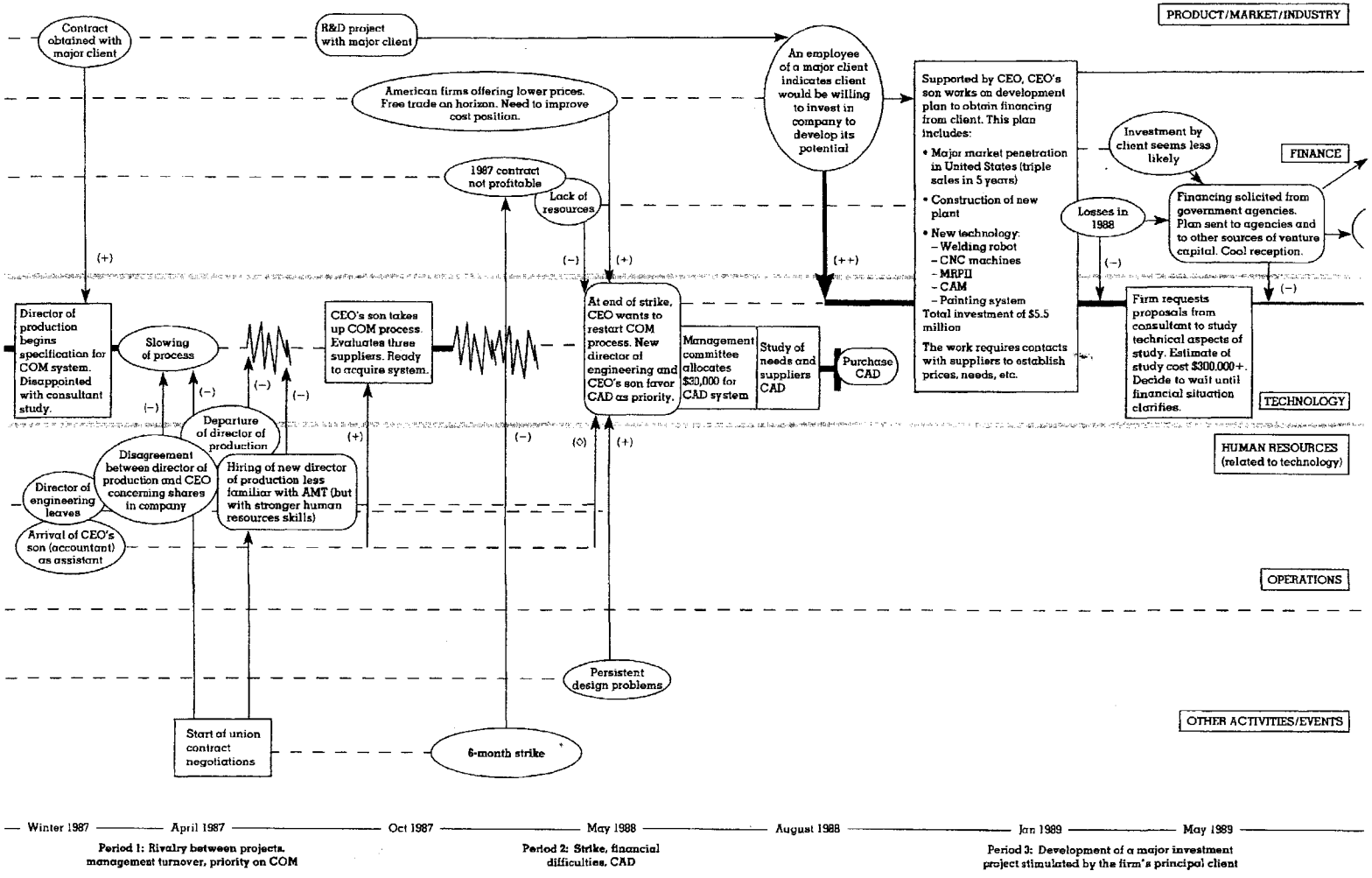


Figure 11. Example of an Event-State Network (Langley & Truax, 1994)

These visual displays hint at important software engineering principles. For example, event-state networks incorporate elements commonly found in finite state automata; activity records embody the principles of modularity and hierarchical decomposition; decision models use flowcharts to capture and express control sequences.

However, as a guide to implementing the TADP in computer simulations, informal visual displays share a number of limitations: (Harel, 1988)

- A linear increase in the number of events will tend to trigger an exponential increase in the number of states, a tendency known as the state explosion problem (Kozen, 1997). Miles and Huberman allude to it in this passage: "A variable with too many arrows leading to it becomes a nuisance, because it multiplies the possible number of streams." (pg. 237)
- Methods such as flow charts (e.g., Figure 10) are fundamentally sequential and can deal with concurrency only in a superficial fashion. Other visual displays can depict concurrency (e.g., Figure 11) but typically without specifying the coordination mechanisms.
- Many visual displays provide for iteration (e.g., Figure 7 on page 21) but typically without specifying the consequences of reentering a state. For example, is the prior history discarded when a state is reentered, or is it fully or partly retained and used as a basis for further processing?

- Visual displays often frequently lack a means for denoting contingent transitions. Consider the flowchart shown in Figure 10. Do these transitions happen *at any time* the conditions are true, or do they occur only when the conditions *change* from false to true? Are conditions evaluated instantaneously, or are they sensitive to the order of evaluation?
- Visual displays can become unwieldy and unreadable when expressing hierarchy, decomposition, recursion, and modularity (e.g., Figure 9).
- Relatively few visual displays attempt to express the preemption of low-level processes by high-level interrupts. Consider the activity record shown in Figure 9. At any point in the process of changing a tire the driver might need to pause to allow traffic to pass. Such a high-level interrupt would clutter the diagram with many low-level transitions.

Harel argued that more precise semantic notations were needed to overcome these limitations, and during the past two decades many improvements have been proposed. Many of these improvements were originally motivated by the need to model reactive systems, which must continuously interact with their environment, respond to changes at unpredictable times, gracefully manage high-priority preemption, handle multiple concurrent tasks, and display considerable operational flexibility – all of which are characteristic of human decision making.

In an influential pair of papers, Osterweil (1987; 1997) raised the intriguing possibility that formalisms originally developed to model computer software could be adapted to model other kinds of processes:

> "In examining the hypothesis that software [engineering] processes are software, there seems to be nothing particularly special about *software* processes. This suggests a hypothesis that processes in general are also software. Confirmation of that hypothesis would be of particular interest as it would suggest that application software technology can also help support the development and evolution of all kinds of processes. In particular it suggests that software engineers might have something of particular value to offer to those who engineer manufacturing systems, management systems, classical engineering systems, and so forth." (Osterweil, 1997, pg. 551)

For Osterweil, process *is* software. He implies that fundamental software principles have direct application to process theory, and particularly the TADP. Forging an explicit connection between process theory and computer software may help advance experimental research on meso-level social phenomena like the diffusion of innovations. Such a role would be consistent with Axtell's view (2003) that computer science and social science are developing a coevolutionary relationship.

Visual formalism are not a panacea, of course. Visual formalisms are firmly aligned with the structured perspective; they have a 'mechanical' feel which is more suitable for capturing structural patterns and relationships (Osterweil, 1997; Langley, 1999) than relating rich historical narratives. However, obtaining a 'thick description' is not always the most appropriate goal, particularly when the intention of a study is to develop a simulation model. Simplicity, precision, and parsimony are important considerations in computational modeling, for it is neither possible nor desirable for simulations to reproduce all aspects of target behavior (Gilbert & Troitzsch, 1999). A

major objective of simulation-oriented process research is predicting which variations are most likely to occur and capturing complex structural and behavioral patterns such as concurrency, iteration, recursion, coordination, and preemption.

2.9.1. The Unified Modeling Language

In software engineeering, the best-known and most successful visual formalism has been the Unified Modeling Language (UML, Booch, Rumbaugh, & Jacobson, 1999), which can precisely specify the interrelationships among a set of concepts *independent of any particular software implementation* (for an introduction to UML for nonprogrammers, see Appendix I). The conceptual alignment between GT and UML is surprisingly close, given their very different origins and intended purpose. This alignment is not immediately apparent, since GT and UML are each defined in terms of their own specialized language. Once this alignment is made explicit (see Table 2) it becomes apparent that UML is well-suited as a partner for theory-building in combination with GT or sequence analysis.

TABLE 2. GROUNDED THEORY AND UML TERMINOLOGY

GT Term	GT Definition (Strauss & Corbin, 1998)	UML Term	UML Definition (Alhir, 1998)
Phenomenon	Central ideas in the data, represented as concepts	Object	An abstract representation of a concrete or conceptual entity.
Category	A concept that stands for a phenomenon.	Class	An archetype for objects which have common attributes, operations, relationships, and semantics.
Subcategory	A concept that pertains to a category.	Subclass	A specialized class which inherits the characteristics of its parent, but which may add or redefine certain attributes and operations.
(There is no counterpart in GT to a UML "property")		Property	An attribute or operation.
Property	A characteristic of a category.	Attribute	A characteristic shared by all objects in a class.
Dimension	The range of variation of properties in a category.	Type	The range of values that an attribute may have.
Axial code	A relationship between a category and its subcategories, or a link between categories at the level of properties and dimensions.	Association	A relationship between a class and its subclasses (generalization) or between classes (aggregation or composition)
Process	A sequence of evolving action/interaction which can be traced to changes in structural conditions.	Operation	A dynamic behavioral process shared by all objects of a given class.
Structure	The conditional context in which a category is situated.	Structure	A static configuration of objects.
Central Category	A conceptual idea within which all other categories can be subsumed.	Base Class	The root class of a generalization hierarchy.
The Paradigm	The integration of structure with process.	The Object Oriented Paradigm	A self-contained collection of structural and behavioral elements that provides a basis for integrated modeling.

2.9.2. Structure and Behavior

UML observes a fundamental distinction between structure and behavior (Alhir, 1998; Douglass, 2004). Structure refers to static organization; behavior refers to dynamic relationships. UML defines three distinct types of behavior (Douglass, 2004, pg. 140-144). The most common is *simple behavior*, in which a specified set of tasks is performed upon request. An object which exhibits simple behavior will always

do the same thing in response to a given input or stimuli, regardless of past history; it is memoryless. The second type is *discrete* or *reactive behavior*, which occurs in objects possessing a finite number of discrete, mutually exclusive states. Discrete behavior is the act of transitioning from one state to another in response to an external event. The third type is *continuous behavior*, which is found in objects which are capable of a potentially infinite number of states; this type of behavior is highly contingent on past behavior and inputs. All software processes can be modeled as some combination of these three types of behavior. Thus, if Osterweil's hypothesis holds, then *all processes – regardless of their domain – can be modelled as variations on these basic behavioral patterns*. These types of behavior will be as applicable to psychological and social processes as they are to software processes.

2.10. Chapter Summary

Eveland (1979) argues that adoption has become a reified concept: "A single act (or a limited set of acts) serves as the criterion for judging the outcomes of the process, and the process itself is usually unexplored." Many staged models of the TADP have been proposed, but most are only weakly supported by empirical evidence, privilege the stages of the process over key events and transition sequences, tend to discount the process of screening alternatives, and ignore important nonlinearities such as interrupts and timing thresholds (Rogers, 2003, pg. 202).

In the DOI literature adoption studies have typically privileged the perspective of research sponsors and change agencies; seldom has the TADP been explored from the perspective of the individual consumer, and decision theoretic perspectives have

been overlooked (Gatignon & Robertson, 1991; Kottonau et al., 2000). As Rogers notes, "diffusion scholars would do well to remember that individual's own perceptions count in determining their innovation behavior" (2003, pg. 116).

Qualitative process research is now well-established as a method for researching the TADP, and the value and understandability of these methods are considerably enhanced by visual displays (Werner & Schoepfle, 1987; Meyer, 1991; Langley & Truax, 1994; Miles & Huberman, 1994; Langley, 1999). Unfortunately, informal visual displays tend to be inadequate for expressing complex notions such as concurrency, iteration, recursion and preemption. More precise notations are needed to overcome these limitations (Harel, 1988). Osterweil proposes that computational formalisms such as UML could be adapted to model processes in general, including human behavior and communication.

Langley, Mintzberg, and colleagues argue that "decision making must be studied *in toto* and *in vivo*, at the individual level to include insight and inspiration, emotion and memory, and at the collective level to include history, culture, and context in the vast network of decision making that makes up every organization" (1995, pg. 261). They offer five suggestions for opening up process research:

- Focus on a new unit of analysis – the *issue* – which is to be traced forward in time, rather than attempting to trace backward in time to discover the source of a decision.

- Use alternative perspectives: zoom inward to more fully explore individual behavior and decision processes; zoom outward to uncover long-term trends and behavioral patterns.
- Supplement retrospective data with longitudinal and real-time data.
- Broaden the scope of research to include personality differences and participant interaction.
- Effect a descriptive stance, and avoid bias toward specific outcomes.

However, the seemingly intractable divide between the structured and anarchic perspectives poses a formidable barrier to further theoretical progress in meso-level domains like DOI. Agent-based social simulation shows great promise as a means of bridging the gap, but it is hampered by the imprecision and incompleteness of previous staged TADP models. To better understand macro-level phenomena like technological innovation, explanatory models of the TADP are needed which characterize the micro-level actions and interactions of consumers in formal computational terms. A new methodological synthesis is needed which adapts existing process research methods to meet the specialized requirements of agent-based social simulation. In the next chapter we shall examine the potential applications of agent-based social simulation to MOT.

CHAPTER 3. ARTIFICIAL MARKETS AS A NEW VENUE FOR INNOVATION RESEARCH

3.1. Agent-Based Social Simulation

In recent years there has been a surge of interest in computer simulation as a means of studying complex social and organizational phenomena which cannot be investigated using more traditional methods (Gilbert & Troitzsch, 1999; Goldspink, 2002). *Agent-based social simulation* (ABSS) is an emerging form of interdisciplinary computational modeling which began emerging during the early 1990's from research strands in distributed artificial intelligence and automata theory (Troitzsch, 1997). A recent survey of 196 self-identified ABSS researchers identified two domains of interest to management and marketing scholars (David, Marietto, Sichman, & Coelho, 2004).

Socio-concrete models use direct observation and statistical data to simulate the behavior of real social systems and organizations. An exemplar of this type is the Artificial Anasazi Project, whose aim was to model the mysterious decline of the Anasazi civilization during the era from 800 C.E. through 1350 C.E. (Dean et al., 1999). This simulation was constructed through the assistance of a wealth of historical data covering environmental conditions, demographic trends, and settlement sites.

Prototyping models are multi-agent systems designed to simulate real environments for strategic planning purposes. An example is TRANSIMS, a massive traffic simulation used to study urban areas such Albuquerque, Dallas/Fort Worth, and

Portland. The TRANSIMS model permits traffic engineers, urban planners, public officials and other interested parties to conduct 'what-if' experiments to see how proposed road construction projects might affect traffic patterns (Beckman, 2001). TRANSIMS was later adapted into the EpiSims model, which evaluates possible responses by public health officials to contain epidemics such as smallpox (Eubank, Kumar, Marathe, Srinivasan, & Wang, 2004).

Four common themes characterize ABSS research: a focus on individual behavior and communication; a preference for bottom-up modeling; an appreciation of the importance of the spatial dimension; and a focus on the micro-to-macro gap. The following sections examine each of these themes in turn.

3.1.1. Individual Behavior and Communication

The primary aim of ABSS is to represent situations whereby global social structures emerge from the behavior and interactions of diverse agents (Drogoul & Ferber, 1994, pg. 130). Agents are autonomous computational processes capable of performing local actions in response to various stimuli and communications with other agents (Drogoul & Ferber, 1994). A range of agent types are possible, from reactive agents which behave according to simple stimulus-response rules to cognitive agents which are driven by internally-generated intentions. Shank (2001) argues that individuals hold a special place in social systems since they act as the unit of propagation of social structures, are intractable to further reductionistic expansion, and act as important causal links through their interactions with other individuals.

3.1.2. Bottom-Up Modeling

Natural phenomena such as ant colonies, birds in flight, slime molds, traffic jams, and forest fires are emergent macroscopic patterns produced by the local interactions of autonomous individuals (Epstein & Axtell, 1996, pg. 33). Emergence is *self-organizing* in the sense that these macroscopic patterns arise, naturally and without *a priori* specification, from the structure and behavior of constituent actors (Epstein & Axtell, 1996; Holland, 1998).

Bottom-up modeling is a different way of seeing the world. It takes an active mental shift for us to perceive the world in terms of decentralized actors and complex multilevel feedback loops, and even then it may be difficult for us to find the right language to describe what we see. Simulation provides a kind of language which is more precise than natural language for reasoning about decentralized social phenomena; Ostrom (1988) described simulation as a third symbol system for inquiry in the social sciences, along with natural language and mathematics.

3.1.3. Spatial Phenomena

In addition to its value in studying the interactions of heterogeneous agent populations, ABSS is also useful for studying spatial phenomena (Epstein, 1999, pg. 42-49; Jager & Janssen, 2003, pg. 11-15). Equation-based models can become intractable if the spatial dimension is included, for it is usually impossible to derive an analytical solution to a nonlinear, multidimensional equation. Simulation is often the only practical option for studying such systems.

The usefulness of ABSS is not limited to physical space; it is also useful for investigating discrete or network space (Epstein & Axtell, 1996; Brassel, Möhring, Schumacher, & Troitzsch, 1997, pg. 58). Physical topography is the most familiar meaning of "space", and it has long been known to be an important factor in the diffusion of innovations (e.g., Hagerstrand, 1967). Ant colonies, termite mounds, and traffic jams are all examples of phenomena where physical space is important. Discrete topography represents space in abstract terms, like a chessboard or hexagonal grid; cellular automata models like Sugarscape exemplify this approach (Epstein & Axtell, 1996). Network topography represents social space in graph form, making it possible to endogenously represent important DOI concepts such as opinion leadership, boundary spanning, and network ties (Coleman, Katz, & Menzel, 1966; Granovetter, 1973, 1978; Rogers & Kincaid, 1981; Valente, 1995). Network topography also links ABSS to important recent advances in 'small world' network theory (Watts & Strogatz, 1998).

3.1.4. The Micro-to-Macro Gap

A deep chasm of complex behavior separates the particular and the universal. Bridging the *micro-to-macro gap* has long been an important goal of social science research (Alexander, Giesen, Münch, & Smelser, 1987; Smith, 1997; Goldspink & Kay, 2004). It may be understood in terms of three levels of perspective. The *micro perspective* focuses on the individual; theories at this level often seek to control or minimize the influence of social forces on the individual (Prietula et al., 1998). The *macro perspective* focuses on large-scale behavior. Individuals are treated in an

aggregate manner, and the complexities of individual behavior are ignored. Mathematical modeling is commonly used at this level (Drogoul & Ferber, 1994; Prietula et al., 1998). The *meso perspective* seeks to explain and predict how macro-level behavior emerges from the micro-level behavior and interactions of cognitively-limited agents. Complex feedback loops between micro- and macro-level processes intersect at this level (Schank, 2001).

It is at the meso-level that ABSS seems likely to make its greatest contributions. ABSS attempts to close the micro-to-macro gap by examining how the actions and interactions of micro-level agents emerge as macro-level forms and patterns. By oscillating between the micro- and macro-poles, it attains the desired synthesis (Gilbert & Troitzsch, 1999). ABSS offers the potential to explore organizational forms which would otherwise remain unobservable. In many cases, ABSS may be the only feasible way to conduct experimental research on social systems. When used as a partner to theory-building, ABSS can help flush out inconsistencies in a theoretical framework and shed light on previously overlooked phenomena (Langley, 1999).

3.2. A Comparison Case: Lotka-Volterra

All of the themes explored in this section – individual-based modeling, bottom-up modeling, the spatial dimension, and the micro-to-macro gap – can be illustrated by the famous Lotka-Volterra predator-prey model (LV, Lotka, 1925; Volterra, 1926). The Lotka-Volterra model has been used for technology forecasting purposes (e.g., Modis, 1999) and is available in both ABSS form and system dynamics

form, thus providing a simple and relevant basis for comparing these two forms of social simulation.

The system dynamics version of Lotka-Volterra (LV_{SD}) is implemented as a coupled system of differential equations given by:

$$\frac{dF(t)}{dt} = F(bR - a)$$

$$\frac{dR(t)}{dt} = R(c - dF)$$

Where *F(t)* is the predator population, *R(t)* is the prey population, *a* is the predator death rate, *b* is the predator birth rate, *c* is the prey death rate, and *d* is the prey birth rate; *a*, *b*, *c*, and *d* are positive constants. The dynamic behavior of LV_{SD} is shown in Figure 12.

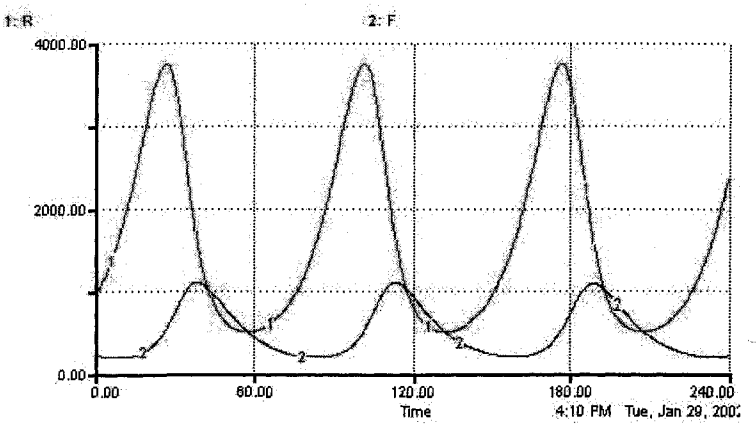


Figure 12. The Lotka-Volterra Model: Dynamic Behavior.

The ABSS version of Lotka-Volterra (LV_{ABSS}) is implemented in terms of individual prey and predator agents who wander a 2-dimensional spatial environment in search of food. The endogenous representation of space leads to some important differences in the behavior of these models:

- LV_{SD} treats predator and prey populations as aggregate quantities. LV_{ABSS} treats predator and prey as individual organisms.
- LV_{SD} ignores the spatial dimension. LV_{ABSS} explicitly takes space into account, leading to the finding that a critical food density is necessary for the predator and prey populations to stabilize.
- In LV_{SD} extinction is impossible for either predator or prey as long as their initial populations are nonzero. In LV_{ABSS} it is possible for the predator to become extinct if the food density drops below a critical threshold.
- In LV_{SD} tipping behavior is deterministic once the equations and their initial values are specified. In LV_{ABSS} tipping is probabilistic, since it is not possible to completely characterize the state-space of the system.

Edwards, Huet, Goreaud & Deffuant (2003) compared an individual-based model of innovation diffusion with its aggregate equivalent. They found that the two approaches sometimes arrived at the same conclusions, but at other times they did not. The distinguishing factor is the degree of behavioral complexity exhibited at the individual level. When individual behavior is simple, the results are more likely to converge; when individual behavior is complex, the results are more likely to diverge. Aggregate measures frequently conceal as much interesting behavior as they reveal (Roberts, Hulin, & Rousseau, 1978). For a more detailed comparison of ABSS, system dynamics, discrete system simulation, and cellular automata, see Brassel, Möhring, Schumacher, and Troitzsch (1997).

3.3. Artificial Consumer Markets

Artificial markets (AMs) are a form of agent-based social simulation in which individual consumers, organizations, or industries interact under realistic market conditions. AMs are a recent development, most having been published within the past five years. Agents of various types may be combined within the same AM, such as simulated firms pursuing various strategies to increase their market share among simulated consumers. Some AMs are simple and abstract (e.g., Izquierdo & Izquierdo, 2007), while others are geographically and demographically realistic models of actual metropolitan areas (e.g., Heppenstall, Evans, & Birkin, 2006); there is broad variation in how AMs represent time, space, social interaction, population demographics, agent heterogeneity, cognitive complexity, randomness, and coordination (Richiardi, Leombruni, Saam, & Sonnessa, 2006). Table 3 summarizes some key traits of AMs.

TABLE 3. KEY TRAITS OF ARTIFICIAL MARKETS

Key idea	Artificial markets: agent-based simulations of consumer behavior
Typical units of analysis	Agents mimicing consumers and/or firms acting and interacting according to local behavioral rules ("agent specifications")
Typical areas of variability	Abstraction vs. realism (environmental, demographic, behavioral); agent interaction mechanisms; agent heterogeneity; role of randomness; temporal and spatial scope; cognitive complexity of agents
Typical parameters	Geographic: population density; home, work, and shopping locations; etc. Demographic: age; gender; income level; etc. Agent: social connectedness; imitativeness; initial adoption status; etc.
Strengths	Simultaneous expression of multiple variables of demand-side markets (e.g. consumer psychology, social networks, product characteristics, competitive environment, distribution channels, marketing strategies); controlled 'what if' experiments on complex market behaviors
Opportunities	Diffusion forecasting; exploring innovation dynamics; education and insight; policy foresight; massively parallel market analysis; profiling new products and services; assessing business models in volatile new markets
Weaknesses	Currently unsolved problems in the areas of specification, calibration, analysis, publication, and replication
Threats	Sensitivity to initial conditions; plasticity

In this section we review the work of a few teams who have pioneered the use of AMs as a tool for studying the diffusion of innovations.

3.3.1. The Consumat Model

One of the earliest AMs was the Consumat Model, which Wander Jager developed for his doctoral dissertation (Jager, 2000). Jager defines a 'consumat' as an artificial consumer who obeys a set of behavioral rules which are derived from the social psychology and evolutionary economics literatures (Janssen & Jager, 1999, 2002).

The Consumat Model defines two dimensions of consumer utility:

- Need satisfaction, which includes both personal and social needs; and
- Experienced uncertainty.

These dimensions determine which strategy the consumat uses (Figure 13.)

		Need Satisfaction	
		Low	High
Uncertainty	Low	Deliberation	Imitation
	High	Social Comparison	Repetition

Figure 13. Decision Strategies in the Consumat Model.

The overall structure of the Consumat Model is depicted in Figure 14.

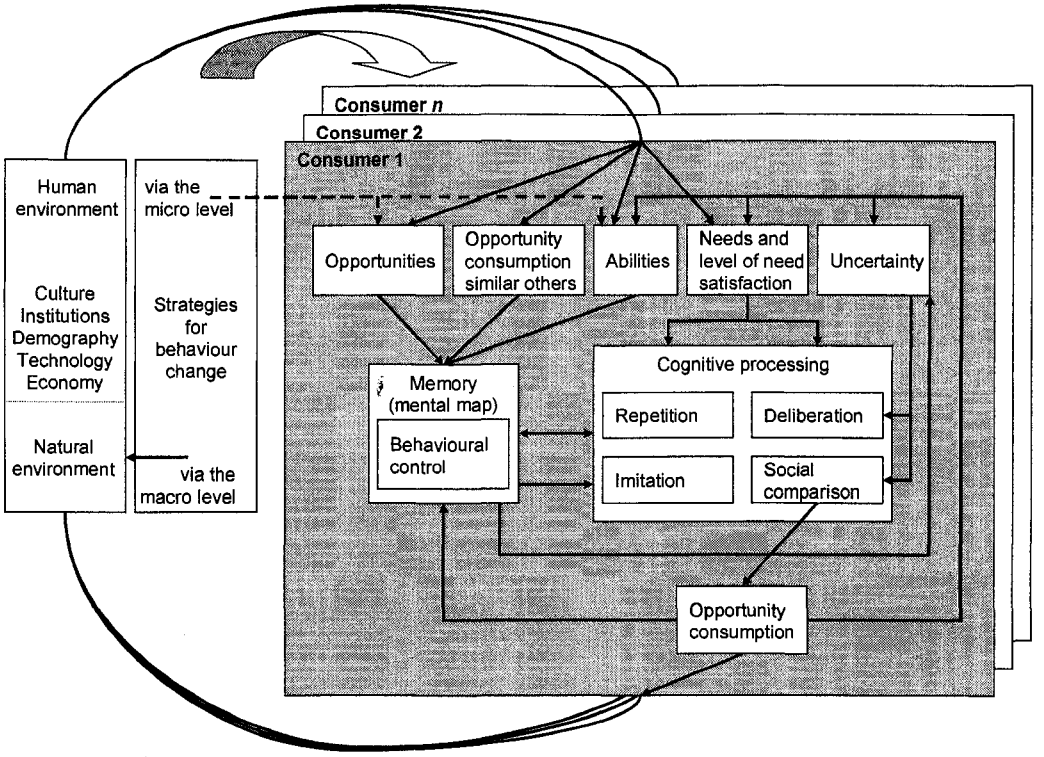


Figure 14. The Consumat Model of Consumer Behavior (Jager, 2000)

Jager and Janssen have used the Consumat Model to simulate:

- Lock-in in monopolistic environments (Janssen & Jager, 1999)
- Lock-in as an entry barrier to green products (Janssen & Jager, 2002)
- Gender and age demographics of consumer cohorts (Jager & Janssen, 2003)

Janssen and Jager (2002) is an illustrative study. The authors investigated the impact of various tax policy scenarios which were designed to encourage the lock-in of green products such as car pooling and car sharing. Their model included innovator and imitator firms in addition to the consumats; in this way, they demonstrated the ability to use ABSS to assess organizational strategies under different taxation and product development scenarios.

3.3.2. The ESP Model

The Episode-based Social Persuasion (ESP) model was created to simulate the diffusion of car sharing programs in Switzerland and Germany (Kottonau et al., 2000). The consumer agents in the ESP model simulate the cognitive process through which habitual car ownership gives way to deliberation and eventual discontinuance. This model is designed to address questions about diffusion dynamics, especially the influence of adoption and rejection on word-of-mouth communication. The model is shown in Figure 15.

The ESP model posits two dimensions of consumer utility:

- Functional utility is what the consumer considers truly useful (e.g., short distance to the car sharing location); and
- Socio-aesthetic utility is a composite of self-consistency, self-esteem, social approval and social consistency (e.g., personal autonomy and the importance of having a 'green' self-image)

The ESP model is sophisticated in the way that it uses the consumer psychology literature. Confirmation bias, status quo bias, sunk costs, negativity bias, memory, attitude formation, and attitude-behavior consistency are all endogenous to the model. The model defines four classes of consumer decision episodes which are similar to Svenson's (1996) four-level decision typology. However, the inclusion of so many psychological factors made each agent so computationally intensive that the simulation could only accommodate a social network of 12 consumers. Nevertheless, the ESP model is an impressive demonstration of the potential of ABSS to serve as a

vehicle for interdisciplinary synthesis of decision psychology and the diffusion of innovations.

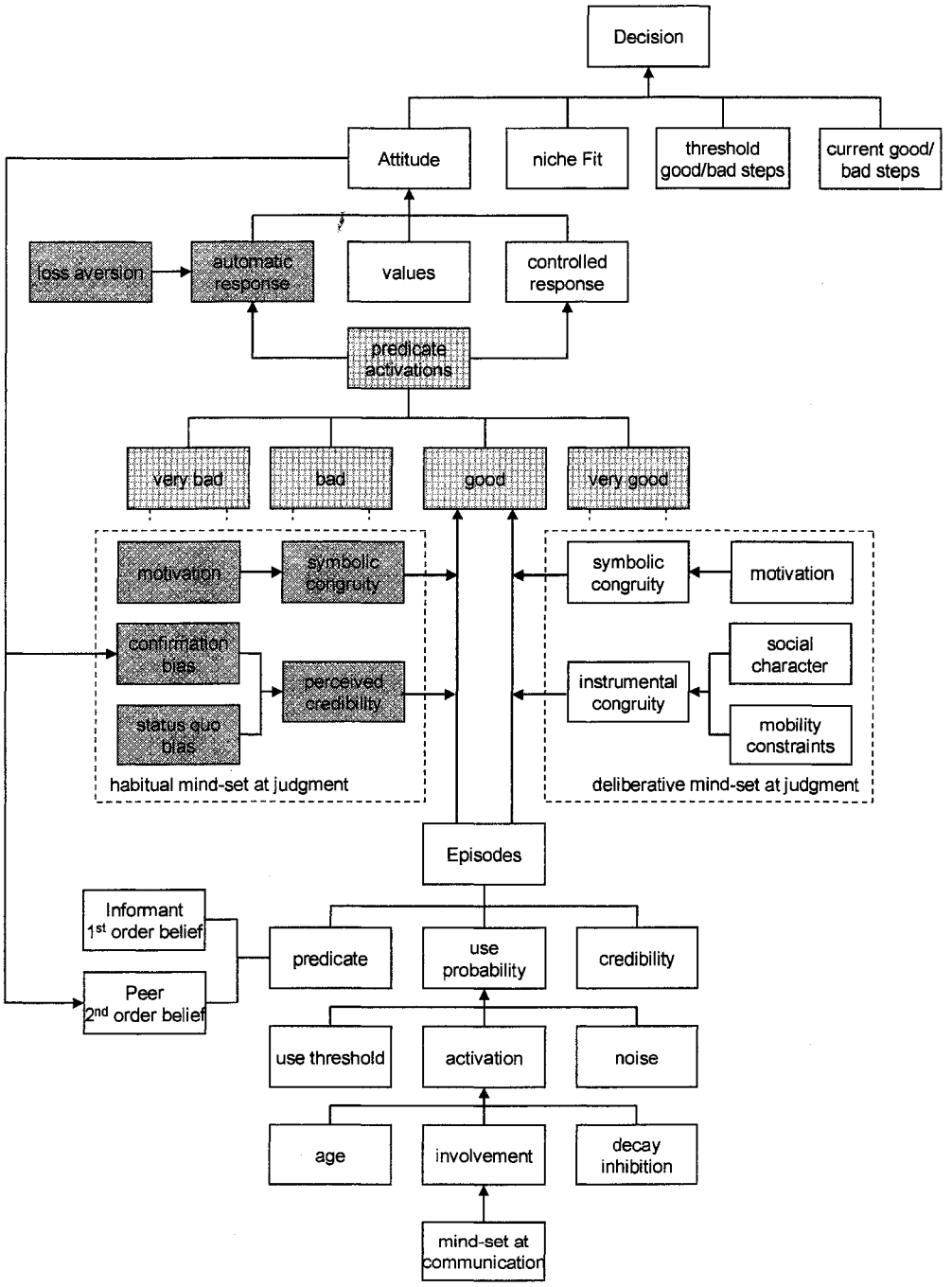


Figure 15. The ESP Model of Consumer Behavior (Kottonau et al., 2000)

3.3.3. The CUBES Model.

CUBES stands for Customer Behavior Simulator (Ben Said et al., 2002). This model simulates competition among several brands in an AM of several thousand consumer agents. It was developed by a team of French researchers who synthesized theoretical concepts in psychology, economics, marketing, and sociology. The model is very abstract and is best regarded as a proof of concept study. The model is shown in Figure 16.

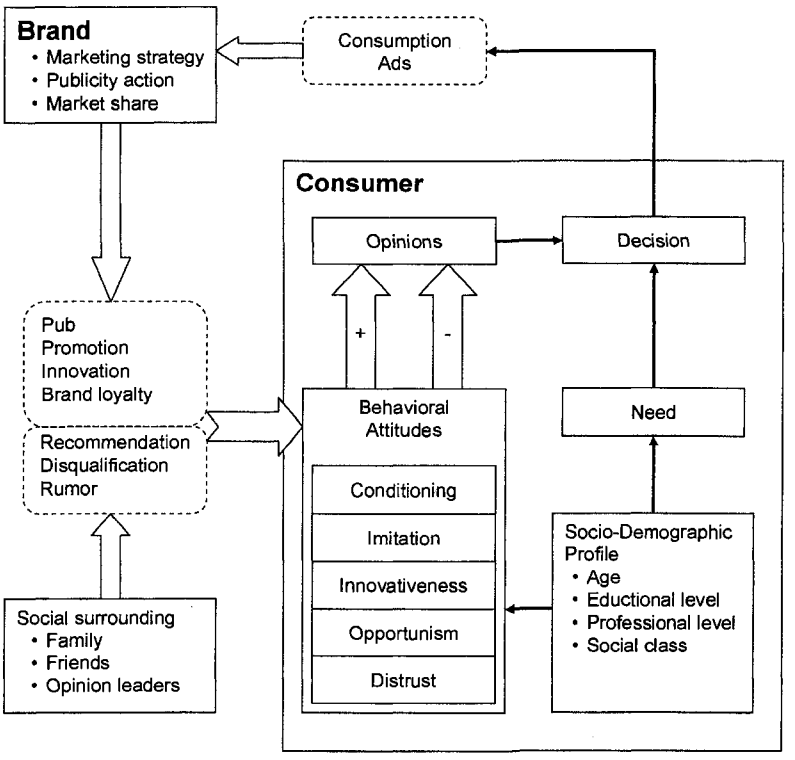


Figure 16. The CUBES Model of Consumer Behavior (Ben Said et al., 2002)

An important assumption of the CUBES model is that it is possible to represent consumer behavior in terms of elementary behavioral primitives which are not specific to purchasing (e.g., imitation, opportunism, mistrust.) The automaton shown in Figure 17 is an example of these generic behavioral elements.

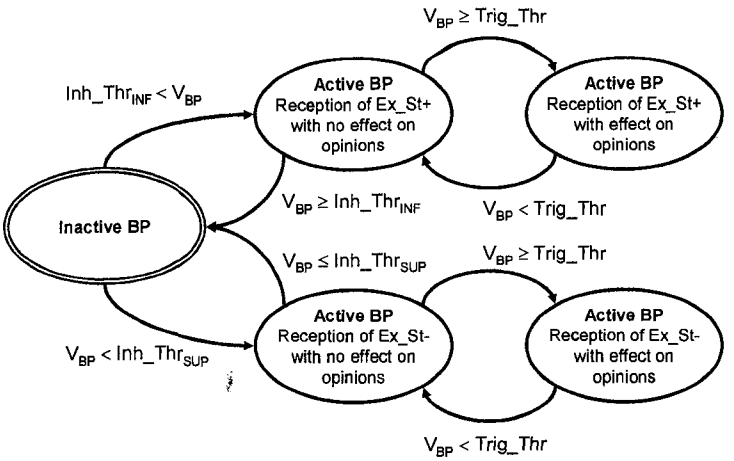


Figure 17. Behavioral Primitive Automaton for the CUBES Model (Ben Said et al., 2002)

The behavioral primitive determines how the consumer agent responds to environmental stimuli. When the consumer agent receives a stimulus, the automaton compares its intensity (V_{BP}) to the appropriate thresholds (Inh_Thr_{INF}, Inh_Thr_{SUP}, Trig_Thr) for the current state (the ovals). If the threshold is exceeded, the agent transitions to a new behavioral state; otherwise, it ignores the stimulus. Thus, the automaton constitutes a simple stimulus-response model of the TADP.

3.3.4. The Project FAIR Model

Project FAIR models the diffusion of green agricultural innovations (Deffuant, Huet, & Amblard, 2005). This team of French researchers later generalized their model to simulate the diffusion of mobile phones, the Internet, contraception, organic products, genetically modified organisms, and cloning. The Project FAIR consumer agents are also driven by a behavioral automaton of the TADP, as shown in Figure 18.

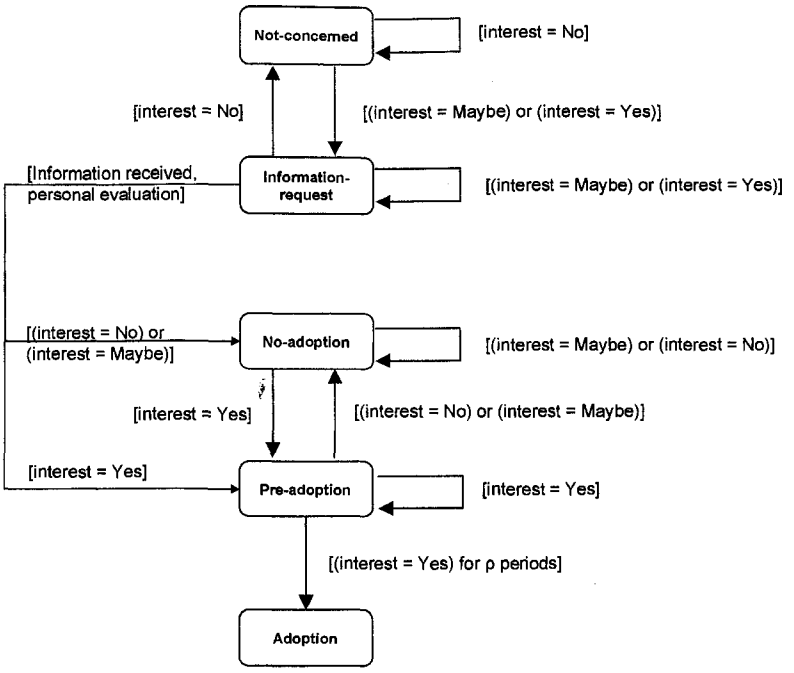


Figure 18. Behavioral Automaton for the Project FAIR Model (Deffuant et al., 2005)

3.3.5. Recent Models

Two workshops have been held on agent-based models of market dynamics and consumer behavior; the first in January 2006 at the University of Surrey at Guildford, UK., and the second in August 2007 at the University of Groningen in the Netherlands. Several new models were introduced to simulate diffusion of water resource management innovations in the upper Danube basin (Schwartz & Ernst, 2006), shoe fashions in the Regensburg region of Germany (Schrödl, Löffler, & Rauh, 2006), transportation mode choice in Amsterdam (Dugundji & Gulyás, 2006), retail gasoline prices in West Yorkshire, UK (Heppenstall et al., 2006), grocery shopping patterns in the Umeå region of northern Sweden (Schenk, Löffler, & Rauh, 2007), and online shopping for bath products in Switzerland (Roach & Gilbert, 2007) to cite a few examples. There has been a surge of AM publications during the past two years as

more fields discover the potential of these models. Several AM studies were published in a recent special issue of the Journal of Business Research, and a special issue of the Journal of Product Innovation Management is currently in preparation. Papers from the 2006 and 2007 AM workshops may be viewed at the Marketing Dynamics wiki: http://www.essa.eu.org/simulation-wiki/MarketDynamicsSIGWiki. A cross-section of AM studies are listed in Table 4.

TABLE 4. CROSS-SECTION OF ARTIFICIAL MARKET STUDIES

Authors	Substantive Domain	Specification Method	Dependent Variable
Janssen and Jager (2001; 2002; 2003)	Car sharing and car pooling	Ad hoc, based on social psychology and economics	Innovation diffusion and lock-in
Kottonau, Burse and Pahl-Wostl (2000)	Car sharing	Ad hoc, based on consumer psychology	Attitude formation
Ben Said, Drogoul and Bouron (2002)	Cellular phones	Ad hoc, based on consumer psychology	Brand competition
Deffuant, Huet and Amblard (2005)	Agriculture, mobile phones, cloning, genetically modified organisms, contraception, the internet, organic products	Ad hoc, based on social networking theory	Innovation diffusion
Schwarz and Ernst (2006)	Water resource management	Theory of Planned Behavior	Innovation attributes
Schrödl, Löffler and Rauh (2006)	Retail shoe shopping	Ad hoc, based on geographic theory	Retail attributes
Dugundji and Gulyás (2006)	Transportation mode choice	Discrete Choice Analysis	Mode split
Heppenstall, Evans and Birkin (2006)	Retail gasoline shopping	Geographically Weighted Regression	Retail attributes
Schenk, Löffler and Rauh (2007)	Retail grocery shopping	Discrete Choice Analysis	Retail attributes
Roach and Gilbert (2007)	Retail internet shopping	Ad hoc, based on consumer behavior	Retail attributes

3.4. A SWOT Analysis of Artificial Markets

In this section we assess the strengths, opportunities, weaknesses, and threats facing AM as they relate to the MOT field.

3.4.1. Strengths

AMs belong to the causal or explanatory class of models in which the relevant variables and linkages are endogenously specified in terms of mathematical equations or simulation code. Models of this class are often used to forecast technology adoption and diffusion (Martino, 1999). To appreciate the strengths of AMs it is helpful to first understand the limitations of existing forms of causal models such as closed-form mathematical equations.

In marketing, the most widely used diffusion forecasting method has been the Bass model and its variants (Bass, 1969). The Bass model is a regression-based method which forecasts the overall shape of the adoption S-curve in a population, the goal being to forecast the adoption rate of a new product or technology. It assumes two primary sources of influence: mass media and word-of-mouth (see Figure 19).

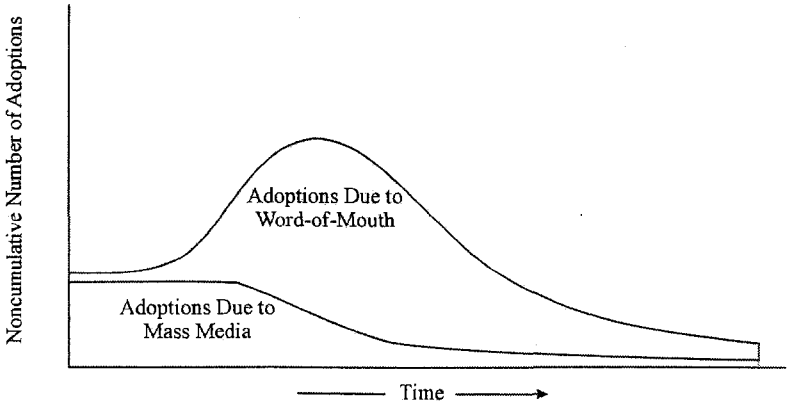


Figure 19. The Bass Model of Diffusion Forecasting (Mahajan, Muller, & Bass, 1990)

Mathematically, the Bass model is given by: (Mahajan, Muller, & Wind, 2000)

$$\frac{dN(t)}{dt} = p[m - N(t)] + \frac{q}{m} N(t)[m - N(t)]$$

Where $N(t)$ represents the cumulative number of adopters, m is the maximum number of adopters, and p and q are coefficients representing the effectiveness of mass media and interpersonal communication respectively. The original Bass model imposed several highly restrictive assumptions: (Mahajan, Muller, & Bass, 1990)

- Adoption is defined as the first purchase of an innovation; people either adopt or they do not. Repeat purchases, discontinuance, and substitution cannot be expressed within this model. The nature of an innovation does not change over time, and its diffusion is independent of all other innovations. Clusters or bundles of interdependent innovations are ignored.
- The model entirely ignores human decision variables (Bass, Krishnan, & Jain, 1994). Adopter populations are assumed to be homogenous and perfectly mixed, with interpersonal influence uniformly distributed throughout a social system of fixed size. Diffusion networks and opinion leadership are ignored.
- The total market potential is constant. Diffusion patterns are not influenced by the marketing mix, advertising strategies, promotional efforts, phased product introductions, distribution channels, supply restrictions, or any other product or market characteristics.

Since so few innovations are capable of satisfying all of these assumptions, a number of refinements have been published to incorporate the influence of the marketing mix (Bass, Jain, & Krishnan, 2000), clusters of interdependent innovations (Bayus, Kim, & Shocker, 2000), marketing strategy and competition (Chatterjee, Eliashberg, & Rao, 2000; Kuester, Gatignon, & Robertson, 2000), stage of adoption (Sharif & Ramanathan, 1982; Dekimpe, Parker, & Sarvary, 1998), non-uniform interpersonal influence and disaggregate populations (Strang & Tuma, 1993; Parker, 1994; Roberts & Lattin, 2000), multiple markets (Dekimpe, Parker, & Sarvary, 2000), product and market characteristics (Golder & Tellis, 1997, 1998; Rangaswamy & Gupta, 2000), supply constraints (Ho, Savin, & Terwiesch, 2002), and repeat purchases (Ratchford, Balasubramanian, & Kamakura, 2000). Unfortunately, there is a shortage of practical advice on how to use these refinements, especially when applied in combination. Most define parameters which are difficult to interpret and require considerable data to estimate. By the time these data have been acquired it is often too late to develop a forecast (Mahajan et al., 1990; Parker, 1994). To summarize, the Bass model yields general information about macro-level phenomena (Brassel et al., 1997) which is of limited usefulness to practitioners (Dockner & Jorgensen, 1988). To progress beyond these limitations, more powerful methods are needed.

AMs are attractive when it is important to simultaneously account for multiple factors in the same model (e.g., consumer psychology, social behavior, product characteristics, competitive threats, distribution channel characteristics, and marketing strategy.) A particular strength of AMs is their ability to endogenously represent

psychological variables; consumer psychology has been largely overlooked by previous diffusion studies (Gatignon & Robertson, 1991; Kottonau et al., 2000). The forté of AMs occurs in demand-side forecasting situations when social interaction and/or cognitive biases are known to be important, when consumer behavior is complex and market behavior volatile, when equation-based modeling would impose too many restrictions, and when controlled experimentation is desirable yet infeasible. These conditions are typical of innovation diffusion (Garcia, 2005).

3.4.2. Opportunities

AMs show great promise for advancing technology futures research (Technology Futures Analysis Methods Working Group, 2004). Linstone (1999) suggests that these models could aid in exploring the dynamics of technological evolution, mapping domains of market stability, developing strategies to stimulate or delay phase changes, and gaining insight into the impact of technology on society. In this section we identify and explore several promising AM applications in the MOT field.

Market forecasting. It has already been noted that AMs are finding practical applications in the area of innovation diffusion when alternatives such as the Bass model are infeasible. AMs are also attractive in situations when social interaction or consumer cognition are known to be important (e.g., viral marketing) or when controlled experimentation is desirable, but currently unfeasible (e.g., evaluating alternative marketing strategies, product characteristics, or product launch campaigns.)

Exploring market dynamics. AMs could be used to explore domains of stability and instability in market behavior, such as factors leading to the establishment of monopoly and monopsony behavior (e.g., Jager, 2000), technology lock-in, substitution, coevolution, or revolution (e.g., Janssen & Jager, 2003), social networking phenomena such as opinion leadership and the s-curve 'chasm' (Moore, 2002), and the emergence of niche markets.

Education and learning. AMs could be used as 'flight simulators' to teach management and marketing students how markets might respond under various conditions and explore 'what if' scenarios.

Policy foresight. AMs could be used in conjunction with scenario analysis to envision desirable future states of nature, develop public policies for achieving these states, evaluate the relative effectiveness of these policy options, and highlight possible unintended or undesirable consequences.

Massively parallel market analysis. AMs could prove useful in retrieving, filtering, and integrating real-world market data, generating useful information from massive databases.

Innovation mining. A particularly novel and intriguing application would apply AMs in conjunction with search algorithms, scenario analysis, and traditional marketing data to develop profiles of products and services which do not yet exist, but which markets are poised and ready to accept. In this hypothetical 'innovation mining' application, an AM could be constructed of a target city or region to reflect the demographics, social networks, adoption status, and preferences of the target

consumer population. After validation testing, a search algorithm could be applied to 'mine' the AM for profiles of innovations that satisfy latent or unmet consumer needs while at the same time exhibit easy adoption paths. Scenario analysis could be used to interpret these innovation profiles and develop descriptions of proposed products and services. Scenario analysis could also be used to interpret future market states predicted by the AM and nominate leading indicators of these states for validation and tracking purposes. The relative probabilities of these states could be estimated with additional simulation runs, after which the results could be fed into normative decision support models. Finally, the viability of the proposed products or services could be tested by means of traditional market acceptability research.

Innovation mining could provide early alerts of innovations whose market window has arrived. As such, it would be a form of technology foresight – a method for identifying future trends and opportunities, then devising strategies to make the most of them. While this application is rather speculative at this stage and a proof of concept demonstration far in the future, our analysis suggests that innovation mining is possible in principle. Regardless of whether it proves to be viable, research on this topic could likely result in theoretical and methodological 'spillovers' that benefit other MOT areas like innovation dynamics.

Gaming business strategy. AMs could generate and assess alternative business models to exploit or defend against disruptive technologies. In this application an AM could be constructed as a volatile market mix of stable and disruptive technologies. Organizational agents representing established and entrepreneurial firms could be

programmed to pursue random business models; the AM would then run until certain conditions had been satisfied (e.g., the surviving number of organizations drops below a certain threshold, indicating a market shakeout.) By replicating the experiment many times, the AM would identify the most promising business models and identify areas of sensitivity. In essence, the AM would permit a market selection experiment to be conducted *in silico*.

3.4.3. Weaknesses

AMs face several currently unsolved problems. In this section we discuss five areas of weakness: specification, calibration, analysis, publication, and replication.

3.4.3.1. Weaknesses: Specification

Specification refers to the task of constructing the simulated consumer agents. Human behavior is complex, and agents are difficult and time-consuming to construct. A good model should "separate the essential from the incidental, cutting through what is deemed irrelevant detail to get at the heart of a problem." (Byrne, 1997, para. 4.1). It should be simple, clear, bias-free, and manageable; simplicity is useful as a starting point, but there is a tradeoff between simplicity and fidelity (Casti, 1997; Gross & Strand, 2000). The challenge is how to specify consumer behavior rules which are realistic and accurate without burdening the model with excessive complexity (Jager, 2007). This tradeoff must be resolved based on the model purpose.

Three styles of agent specification appear in the AM literature which it is useful to call the ad hoc, theory-first, and theory-later approaches. The *ad hoc*

approach is often used to explore market behavior at a high level of abstraction, as was the case in Epstein and Axtell's Sugarscape model (1996). The usual goals which motivate this approach are learning, exploration, and insight, and these are best achieved with simple agent behavioral rules. Highly abstract AMs may define arbitrary rules: "The main constraint we impose on ourselves in constructing such rules...is to make them as simple as possible...practically, we want to be able to state a particular rule in just a few lines of code" (Epstein & Axtell, 1996, pg. 22). More typically, rules are synthesized from multiple theories in a particular field such as consumer behavior or social psychology; the macroscopic market behavior which emerges from these rules is then compared to the target phenomena to validate the findings. It is characteristic of the ad hoc approach that validation occurs at the macro-level; little or no effort is made to validate the micro-level behavioral rules against the actual behavior of consumers in those markets. Nor is any significant effort devoted to testing the correspondence between the rules and the theories from which they have been derived; since the rules are typically a synthesis of several different theories, such correspondence is difficult to test. Changing the micro-level consumer behavior usually changes the macro-level market behavior (Epstein & Axtell, 1996, pg. 86; Durlauf, 1997) so only limited conclusions may be drawn with this approach.

The *theory-first approach* derives the agent rules from a specific behavioral framework. For example, Dugundji and Gulyás (2006) used discrete choice analysis to construct an AM of transportation mode adoption in Amsterdam, while Schwarz and Ernst (2006) used the theory of planned behavior to simulate diffusion of water

resource management innovations in the upper Danube basin. Explicitly linking the agent behavior to extant theory makes the theory-to-model correspondence easier to establish and strengthens the validity of the simulation. There is much to be said for the theory-first approach in terms of its overall efficiency, validity, and ease of incorporating empirical data into the AM, and it is overtaking the ad hoc method as the dominant approach to consumer agent specification.

That said, there are few behavioral frameworks which are precise, formal, and complete enough to support the theory-first approach (McKelvey, 1999; Goldspink, 2002). To the extent that a theory is imprecise, informal, or incomplete, it increases the difficulty of deriving a set of behavioral rules from that theory, blurs the distinction between ad hoc and theory-first modeling, and limits the conclusions which may be drawn from the AM.

Consider the TADP, a key behavioral process for AMs. The Consumat, ESP, CUBES, and Project FAIR models all assume that it is possible to express adoption in terms of behavioral primitives for imitation, repetition, trust, opportunism, etc. and all define behavioral automata analogous the one shown in Figure 18 on page 63.

Figure 18 was developed by means of the ad hoc approach; let us suppose we instead wished to derive it using the theory-first approach. Chapter 2 revealed that at least 34 staged models of adoption, consumer purchasing, decision making, and problem solving have appeared over the years. Most of these depict the TADP as a linear progression of stages, with branching, exceptions, interrupts, parallelism, and iteration either glossed over or ignored entirely. This poses an immediate problem,

since these phenomena are all important when specifying a behavioral automaton. Turning to studies which have used 'stage of adoption' as an independent variable, in Chapter 2 it was also found that the empirical support for staged TADP models is rather weak, with evidence of overlapping stages, difficulty in clearly distinguishing between stages, skipped stages, out-of-order stages, truncated search procedures, interruptions and disjointed progress, and coincidental confluence of problems, solutions, decision makers and choice opportunities. Most staged TADP models require liberal interpretation before they can be translated into agent specifications, which increases the risk of introducing unintended behavioral artifacts (Axtell, Axelrod, Epstein, & Cohen, 1996; Casti, 1997). The present state of agent modeling practice does not adequately safeguard against this risk (Drogoul, Vanbergue, & Meurisse, 2002; Midgley, Marks, & Kunchamwar, 2007).

AM would greatly benefit from new CAPT of greater precision and formality than has been typical of past staged models (Kottonau et al., 2000; Ben Said et al., 2002; Goldspink, 2002; Klüver et al., 2003; Zhang & Zhang, 2007). Despite the vast size of the adoption literature, there is a shortage of the kind of research that could help guide the theory-first specification of behavioral primitives like Figure 18.

When extant theory is inadequate or new perspectives are desired, the *theory-later approach* may be attractive. In this approach agent modeling is combined with qualitative techniques such as case studies, grounded theory, or sequence analysis to construct theories that are grounded in a deep engagement with the consumer experience, and yet possess the degree of precision and formality needed to support

consumer agent construction. An example of this approach is Andrews, Baptista and Patton (2005), who used grounded theory to construct an agent-based simulation model of worker behavior in a small plastics manufacturing firm. The theory-later approach recognizes that prior theory may run at cross-purposes with the need to observe consumers *in situ* for subtle but important behavioral cues (Agar, 2003, 2005). Listening to the customer is an important aspect of management and marketing (Zaltman, 1997) and much the same may be said of consumer agent modeling.

The theory-later approach has its own drawbacks. Methodologies guiding its application are virtually nonexistent. Furthermore, it is a time-consuming and analytically demanding approach which requires intense interaction among simulation modelers, consumer field researchers, and subject matter experts; a diverse team is needed. Theory-later is a decidedly minority approach at present, but it may yet increase in popularity as qualitative research methods gain acceptance in mainstream management and marketing research (Locke, 2001; Arnould & Epp, 2006).

3.4.3.2. Weaknesses: Calibration

Calibration is the task of initializing the AM so that its parameters and variables accurately reflect the characteristics of the real-world target system. Calibration and specification are distinct activities; an AM can be entirely probabilistic (e.g. by basing behavioral rules on discrete choice analysis) and still incorporate empirical data to calibrate the various geographic, demographic, and agent parameters. It is entirely possible to use empirical data to calibrate an AM but not to specify it, and vice versa.

Calibration is a challenging task (Drogoul et al., 2002; Fung & Vemuri, 2003; Fehler, Klügl, & Puppe, 2004; Boero & Squazzoni, 2005; Moss & Edmonds, 2005; Garcia, Rummel, & Hauser, 2007; Midgley et al., 2007). Data may be difficult to acquire or measure directly, and in their absence the model parameters may only be estimated (Goldspink, 2002). Even when data are available, they may not be clean or captured in a useful form. The calibration problem is particularly acute in AMs because of the need to realistically generate large populations of agents from relatively small samples (Drogoul et al., 2002; Jager & Janssen, 2002; Fehler et al., 2004). The challenge here is how to generate a synthetic agent population which is statistically indistinguishable from a target population. Demographic data (e.g. age, income, sex, and household composition) may be obtained from public sources and incorporated into the AM by means of statistical techniques such as iterative proportional fitting. However, data on cultural norms, attitudes, social connectivity, and personality factors may be more difficult to come by. Traditional marketing tools such as surveys and conjoint analysis may be useful in this regard (Garcia et al., 2007), especially when applied in combination with theory-later specification.

Piana (2004) argues that it should always be possible to convert the behavioral rules of consumer agents into questions for real consumers in questionnaires. This is important to achieve empirical feedback, calibration, and validation of the AM, as well as to help ensure that the agent specifications do not become so contrived that they defy description in ordinary terms. At present, few methodologies exist to help link consumer questionnaires to agent behavioral rules; more research is needed.

3.4.3.3. Weaknesses: Analysis

AM simulations can be quite complex, and great care is needed to avoid simply substituting one difficult-to-understand system for another. Lack of validation is a major reason for the rejection of agent-based simulation models (Leombruni & Richiardi, 2005). New techniques are needed to support model verification and validation, sensitivity analysis, output analysis, system comparison, and visual representation of results. In particular, research needed on how to validate findings generated by AMs (Chattoe, Saam, & Möhring, 2000; Moss & Edmonds, 2003; Richiardi et al., 2006; Marks, 2007; Midgley et al., 2007).

3.4.3.4. Weaknesses: Publication

Even simple agents can produce quite complex emergent behavior which can be difficult to summarize. It is no easy matter to condense AM findings into the limited space of a journal article. The challenge here is how to communicate the essential features of the model and convey understanding and insight without overwhelming the reader with detail.

Some authors (e.g., Axelrod, 1997; Goldspink, 2002) have argued that the publication problem could be addressed by relying on online journals, which are not bound by space limitations, or by posting simulation source code to the web. These measures are unlikely to prove satisfactory, since the publication problem is common to all large software systems, and is not unique to AMs. Source code cannot be made self-documenting, no matter how carefully it is written (McConnell, 1993). Neither is it practical to publish ever-longer specifications, since experience suggests that these

will simply gather dust on the shelf. The current trend being pursued throughout much of the software industry is to break large, monolithic software systems into modular components for independent validation and publication (e.g., Cheesman & Daniels, 2001; Heineman & Councill, 2001), and this approach could be profitably applied to AMs as well.

Component-based approaches are sometimes used to build cognitive agents. Cognitive modeling is a daunting task, and researchers must sometimes reduce its scope by developing partial models of human behavior and communication (Pew & Mavor, 1998; Zachary, Campbell, Laughery, & Floyd, 1998, pg. 10). These partial models then crucially depend on their software architecture to provide an integrative framework within which to compose a viable cognitive agent (Sun, 2006). Modular architectures are needed for consumer agent modeling.

3.4.3.5. Weaknesses: Replication

After publishing a simulation it is important for independent teams of researchers to replicate the results, for many types of errors can go undetected (Goldspink, 2002). Simulation is prone to a wide variety of errors including conceptual mistakes in the model, ambiguities when rendering the model into a specification, programming errors in the specification, and errors in analyzing the simulation output. Edmonds and Hales go so far as to state that "an unreplicated simulation is an untrustworthy simulation – do not rely on their results, they are almost certainly wrong...in the sense that, at least in some detail or other, the implementation differs from what was intended or assumed by the modeler." (2003,

para. 12.2, emphasis original). Unfortunately, replication is seldom performed in practice, and many things can go wrong even when it is attempted (Axelrod, 1997; Bruderer & Maiers, 1997).

3.4.4. Threats

AMs also face limitations which stem from fundamental threats rather than mere weaknesses in current understanding or practice. In this section we will examine two of these threats and suggest strategies to mitigate and offset their impact.

3.4.4.1. Threats: Sensitivity to Initial Conditions

Sociotechnical systems are notoriously difficult to forecast; predictions are usually qualitative and very often inaccurate (Ascher, 1978; Porter et al., 1991). Forecasting problems arise in part because sociotechnical systems exhibit sensitivity to initial conditions which limits the usefulness of historical data (Linstone, 1999). For example, at least 112 distinct typewriter designs were produced during the period from 1714 to the 1860s (Shermer, 1995). Who could have predicted in advance that the Remington model in particular would emerge as the standard design?

Some have argued that sensitivity to initial conditions effectively rules out prediction, at least for complex nonlinear systems involving deterministic chaos (e.g., Seror, 1994). However, sensitivity to initial conditions is a function of the system structure. Complex nonlinear systems may be extremely sensitive to certain types of change, while highly stable in regard to others (Goldspink, 2002). Basins of stability frequently exist within complex nonlinear systems, and these may provide some basis

for at least qualitative prediction. Thus, while it may have been futile to predict when a stable typewriter design would emerge, or what form it would eventually take, the fact that 112 designs were produced over a span of 150 years suggests that the *need* for the typewriter was quite stable, even as the rest of the world changed almost beyond recognition.

3.4.4.2. Threats: Plasticity

Nobel laureate Herbert Simon established that people use only limited information when making decisions, and settle on acceptable outcomes after only a moderate search – even though these outcomes may not be ideal or optimal (Simon, 1956; Newell & Simon, 1972). Human decision making is sensitive to context. Which factors are considered – and the order in which they are considered – determine the decision outcome (Plous, 1993). This sensitivity to context is called plasticity.

Certain AM applications such as innovation mining require data on latent consumer needs. This poses a major problem, since consumers are by definition unaware of these needs. However, identification of latent needs is not a new problem in marketing research (Levy, 2001) and various projective techniques have been developed to elicit such data (Spiggle, 1994; Mariampolski, 2001; Smith & Fletcher, 2004; Arnould & Epp, 2006). These could prove useful, especially if applied in conjunction with theory-later specification.

While careful research can minimize the effects of plasticity, it can never be entirely eliminated. Plasticity will always constitute a limitation on results obtained

solely by AMs. Therefore, triangulation of methods and sensitivity analysis may be necessary when pursuing AMs in MOT research.

3.5. Chapter Summary

In this chapter we reviewed the AM literature and identified the strengths, weaknesses, opportunities, and threats facing AMs as they pertain to MOT research. AMs are especially strong for the study of technology diffusion, where complex social interactions limit the usefulness of equation-based forecasting techniques like the Bass model; they also show great promise for exploring innovation dynamics, policy foresight, education and training, analysis of massive market data, generation and evaluation of business strategies in volatile markets, and the profiling of new products and services. Before AMs can deliver on this promise, however, they must overcome several weaknesses and threats in the areas of agent specification, calibration, analysis, publication, replication, sensitivity, and plasticity. We offer seven recommendations when using AMs for MOT research.

1. *Strive to balance simplicity with fidelity.* To ensure credible results, consumer agents should be behaviorally realistic (Jager & Janssen, 2002; Pahl-Wostl & Ebenhöh, 2004) without overloading the model with extraneous detail (Midgley et al., 2007). Simple models are useful for learning and insight, but the limit the kinds of conclusions which may be drawn. Realistic models may be more convincing, but are difficult to validate. This tradeoff must be resolved on the basis of the model purpose (Casti, 1997; Gross & Strand, 2000).

2. *Reexamine important but reified concepts.* Concepts like 'adoption', 'decision', 'technology', 'innovation', 'market' and 'environment' are sometimes reified – applied without much critical examination. CAPTs of these phenomena are needed that are grounded in empirical data and stated in more formal and precise terms than has been typical of past theories. Computational formalisms like UML could be helpful in sorting out some of the conceptual questions which lurk beneath the surface of these reified concepts.

3. *Incorporate the voice of the customer in consumer agent models.* When it is important to capture consumer behavior with all of its biases, heuristics, and shortcuts, the theory-later approach could be useful as a means of grounding agents in "differences that make a difference" to real human beings in actual market settings (Agar, 2005) especially if combined with existing qualitative consumer research techniques. Methodologies for theory-later agent specification are in short supply; more research is needed in this area.

4. *Ensure that agent decision rules can be converted into questions for consumers.* When consumer questionnaires which are linked to the agent specifications it is easier to incorporate empirical feedback, thus easing the calibration and validation problems (Piana, 2004). Few methodologies exist for constructing consumer questionnaires from agent behavioral rules; more research is needed.

5. *Look beyond closed consumer agent architectures.* Monolithic, self-contained simulation models typically make no provision for the reuse of their constituent parts by other models (Axtell et al., 1996; Burton, 1998; Edmonds &

Hales, 2003; Hales, Rouchier, & Edmonds, 2003). Opaque models are difficult to validate, publish, replicate or reuse. By contrast, a component-based approach would help open up the 'black box' of consumer agent specification, reducing the scope of the task while at the same time creating additional opportunities for piecewise validation, publication, replication, and reuse. In the long run it would also reduce the time and expense needed to develop AM models. There is much to be said for modular simulation architectures in terms of validity, generality, parsimony, clarity, practicality, and computational efficiency.

6. *Look for basins of stability.* When using AMs to study volatile market behavior, it may be product to identify which aspects of the environment are less likely to change over the time scale of the study. These could provide a stable foundation for qualitative prediction.

7. *Triangulate AMs with complementary methods.* To mitigate the impact of plasticity and sensitivity to initial conditions, AMs should be triangulated with methods which are less susceptible to these threats.

CHAPTER 4. METHODOLOGY AND DATA COLLECTION

This chapter introduces grounded agent modeling, a method for constructing behavioral agents from qualitative field research. This approach decouples the agent microspecification from the simulation model for independent validation, thus offering certain advantages over theory-first agent specification methods.

Grounded agent modeling is a hybrid methodology which draws on existing software engineering and social science techniques. Inductive case studies, grounded theory, and sequence analysis are used to investigate transportation mode adoption and construct a theoretical framework of sufficient precision and formality to guide its implementation in UML. The objective is not to construct a working simulation, but rather to construct a theoretical framework which, after further validation and testing, could be integrated as a component in an agent-based simulation. The long-term research goal is to construct a component-based model which is grounded in empirical data, supplies its own calibration instrument, and is suitable for implementation and reuse across a wide range of agent simulation platforms.

The substantive topic for the study is the psychological process by which transportation consumers adopt alternatives to single occupancy vehicles such as transit, bicycles, and car sharing. This topic was chosen because commuting decisions are driven by powerful, readily discernable forces which facilitate qualitative inquiry by bringing the underlying linkages and processes to the surface (Andreasen, 1991). Two sets of exploratory research questions are posed:

RQ-1. *How do consumers make adoption decisions?* What are the characteristic states and events of the process? Which transition patterns are observed to occur? How do consumers limit the time and effort they expend on the process? How do they respond to interruptions? How is the adoption process bounded in time?

RQ-2. *How might a grounded agent model be constructed from empirical evidence?* How might its structure and behavior be derived from *in situ* observations?

4.1. Methodological Choices

Four major methodological choices were made in pursuit of these questions: 1) to cultivate a theory-later stance on agent modeling in preference to a theory-first stance; 2) to structure the field study around case-oriented process research; 3) to pursue theory-building in parallel with model-building, and 4) to capture data on both the structural and behavioral aspects of adoption.

4.1.1. Theory-Later Stance

Outsiders and insiders may disagree as to what really makes a difference in a given social setting. In the social sciences there has been longstanding disagreement as to the advantages and drawbacks of outsider versus insider perspectives. In the outsider or theory-first stance, development is deductive: the researcher proposes certain constructs, develops hypotheses, and tests them against the target phenomenon. This approach is exemplified by Dugundji and Gulyás (2006), who used discrete

choice modeling theory to construct an agent-based simulation of transportation mode adoption in Amsterdam.

In the insider or theory-later stance, development is inductive: the phenomenon of interest is first observed to identify which units of analysis are relevant to the participants in a given social setting; once these have been determined, a theory is developed and validated according to criteria that are germane to that particular setting. This approach is exemplified by Andrews, Baptista and Patton (2005), who used grounded theory to construct an agent-based simulation model of worker behavior in a small plastics manufacturing firm. While each approach has its merits and drawbacks, this study will adopt the theory-later stance.

4.1.2. Case-Oriented Process Research

Process research seeks to discover causal relationships and patterns in the sequence of events over time. Mohr contrasted it with 'variance' research, which seeks to determine the covariance and correlation among variables, independent of their time order. The aim of process research is to construct theories explaining the time order of events; it does not concern itself with variables which might influence the rate or outcome of these events (Mohr, 1982). Process research is less structured and more qualitative than variance research; typical methods include case studies, grounded theory, and sequence analysis (Langley, 1999). Sometimes these methods are applied in combination (e.g., Leonard-Barton, 1990).

Case studies are descriptions of past or present phenomena which are developed from multiple sources of evidence (Eisenhardt, 1989; Yin, 2003). A

defining feature of case studies is the utilization of multiple sources of evidence (e.g., interviews; direct observation; participant observation; archival or source documents.)

Grounded theory is a method for building theories through the systematic comparison of data (Strauss & Corbin, 1998). It produces a theory which is suitable for insight and understanding into one particular phenomenon. Grounded theory does not test hypotheses; instead, it relies on constant comparison and an active search for disconfirming information to construct a theory which is an accurate description of the phenomenon of interest.

Sequence analysis is a suite of analytical tools for developing explanatory process models. It uses event predictor variables to identify similarities and patterns in chunks of coded data (Miles & Huberman, 1994). These variables may eventually be used to make predictions and test the emerging theoretical framework.

4.1.3. Parallel Theory-Building and Model-Building

When developing a CAPT which is specifically intended for implementation as a simulated human agent it can be useful to pursue theory-building and model-building in parallel. A *theoretical framework* is a natural-language causal explanation of a target phenomenon; a *grounded agent model* (GAM) is the formal, modeling-language counterpart to that framework. To apply a software engineering analogy, the theoretical framework corresponds to the system requirements, while the GAM corresponds to the system design.

The GAM is an integral part of data analysis which emerges iteratively and in parallel with the theoretical framework. It is not merely an addendum to the theory,

because it helps keep inquiry focused along lines which were likely to be productive, thereby improving the efficiency of data collection. The GAM also helps to identify where ambiguities exist in the theory that need to be worked out in relation to the evidence. This symbiotic relationship is illustrated in Figure 20.

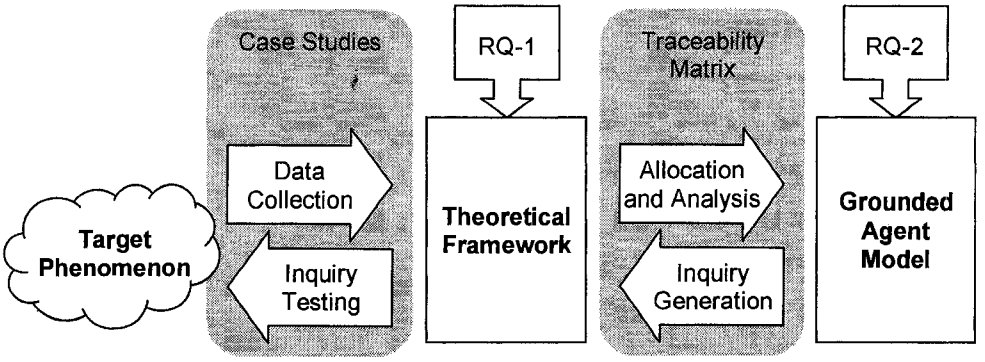


Figure 20. The Theory-GAM-Target Relationship

Construction of the theoretical framework proceeded per Eisenhardt's (1989) strategy for building theories from inductive case studies and Dubin's (1978) principles for constructing explanatory theories. Construction of the GAM was guided by the principles of object-oriented software analysis (Meyer, 1997; Douglass, 2004).

4.1.4. Structure and Behavior

In process research it is often useful to distinguish between structure and behavior. Structure refers to the key concepts and static relationships of a process. Behavior refers to patterns in a series of events over time. Structure and behavior are thus complementary views of a process. In UML, structure is expressed with class and object diagrams, while behavior is expressed using sequence, collaboration, statechart, and activity diagrams.

To build the GAM it was desirable to collect structural and behavioral evidence. To unpack the structure of the adoption process a range of outcomes needed to be sampled (i.e. maximum variation sampling.) This meant relying on retrospective data, since the outcomes needed to be known in advance. To study behavior, it was important to observe the process as it unfolded; this meant collecting longitudinal or real-time data where the outcomes could not be known in advance. These conflicting needs presented a challenge: how can structural and behavioral evidence be collected within the context of a single research design without posing thorny data collection and analysis problems?

This conflict was resolved by employing a two-case complementary assistance research design. Complementary assistance is a triangulation technique which is useful when two different methods are needed in pursuit of the same research objective (Morse, 1991; Morgan, 1998). It requires explicit consideration of the relative priority and sequence of the two methods (see Figure 21.) During the first case, higher priority was given to structural analysis and retrospective data collection was used (following Morse's notation, STRUCTURE+behavior.) During the second case behavioral analysis was given higher priority and data collection was longitudinal (structure+BEHAVIOR.)

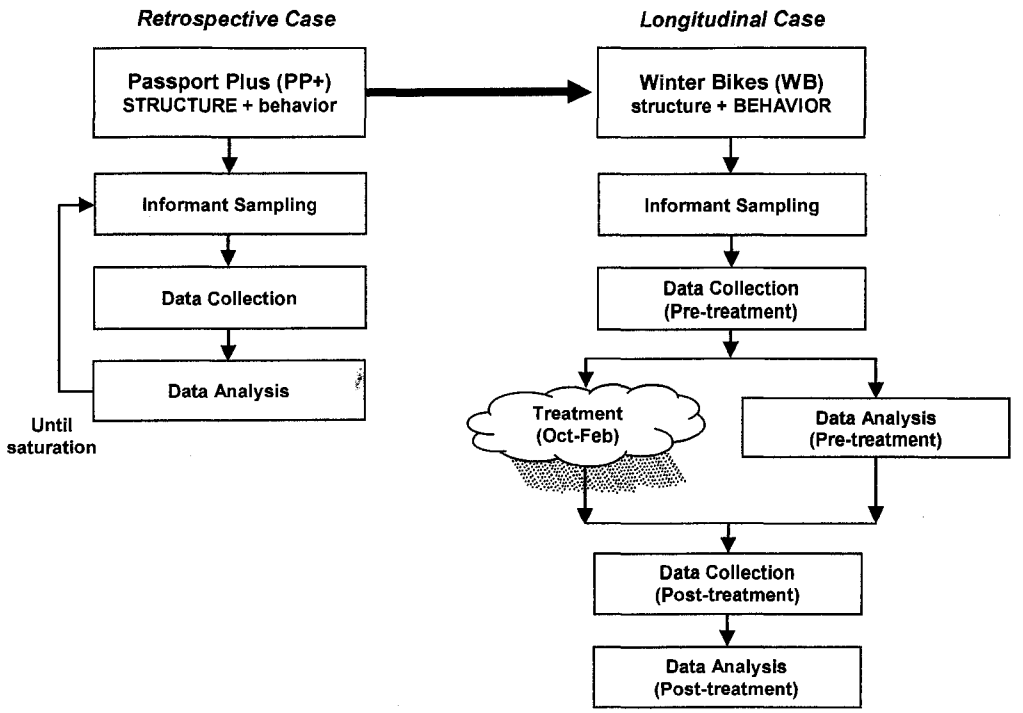


Figure 21. Research Design

4.2. Case Design

Case selection was guided by Yin's (2003) replication logic strategy. The primary case selection variable was the degree of user commitment, per Svenson's (1996) typology of decisions:

Type I Unconscious, quick, and largely automatic decisions.

Type II Conscious decisions made on the basis of a few attributes or immediate emotional reactions.

Type III Conscious resolution of tradeoffs between conflicting goals.

Type IV Active search and construction of alternatives.

It was not feasible to investigate all four of Svenson's decision types within the context of a single study due to inherent conflicts in the time horizons of these

decisions. A decision was made to focus on Types III and IV at the exclusion of Types I and II; thus, the study findings are only generalizable with respect to Type III and IV decisions.

4.2.1. The Retrospective Case: Passport Plus (PP+)

The retrospective case investigated transportation mode adoption among participants in Portland State University's Passport Plus program, an annual pass which entitles the bearer to the use of light rail, bus, the Flexcar car sharing service, and reduced rate campus parking in any desired combination. The objective of this case was to unpack the properties and dimensions of adoption by investigating how participants in this program made choices and tradeoffs from among the available options. This case was selected as a sample of a Type III decision.

Recruiting posters (Appendix A) were posted around the PSU campus at TriMet bus and streetcar stops, Flexcar locations, campus parking garages, and departmental bulletin boards. Telephone prescreening (Appendix B) was used to amass a pool of PSU faculty or staff informants who were at least 21, had currently owned or operated a car during the previous year, and were either current members of the program, were currently considering participation, or had participated within the past two years.

The purpose of the study and confidentiality safeguards were discussed with each informant during telephone prescreening and again at the beginning of the interview. Signed informed consent forms (Appendix D) were collected prior to the interviews. Primary informants were assigned identification numbers, and names were

not used in any of the transcripts or other data. A few secondary informants who were interviewed in an official capacity were given a special consent form granting explicit permission to quote them by name.

Maximum variation sampling was used to solicit informants for a range of personal innovativeness, adoption status, 'greenness', and potential for contributing to the emerging theoretical framework. Innovativeness was assessed by asking informants to self-rate their willingness to try new technologies on a five-point scale, with one indicating the least willingness and five indicating the most willingness. Adoption status was assessed by administering the Concerns Based Adoption Model (CBAM) to all informants during the telephone prescreening (Appendix B.) Assessing 'greenness' was more problematic, since this concept is invested with positive value. Some informants were recruited whose first use of transit did not occur until after the age of 18 in order to avoid oversampling lifelong transit users. All informants were asked to complete a short questionnaire intended to classify their attitudes toward car use; this instrument was adapted from the Transtheoretical Model (Prochaska & DiClemente, 1984) and is listed in Appendix F. These questionnaires were collected at the outset of interviews, then set aside and not tabulated after until the bulk of the analysis was completed to facilitate comparisons with a rival adoption framework. During the interviews no informant cited environmentalism as a leading factor in their decision making, suggesting that the case did not oversample 'green' informants and that a wide range of environmental attitudes were naturally present. The informant sampling results are listed in Table 5.

TABLE 5. PP+ CASE INFORMANT SAMPLING

Innovativeness	CBAM Classification		Transit History	
1: $n = 0$	0 (Nonuse):	$n = 1$	First use before age 18:	$n = 7$
2: $n = 2$	I (Orientation):	$n = 2$		
	II (Preparation):	$n = 1$		
3: $n = 3$	III (Situational Use):	$n = 1$		
	IV (Routine Use):	$n = 1$	First use after age 18:	$n = 3$
4: $n = 3$	V (Integration):	$n = 1$		
	VI (Renewal):	$n = 4$		
5: $n = 2$	Unclassifiable:	$n = 4$		

To help ensure complete coverage of CBAM states, classification scores were computed for more than one technology (e.g., TriMet and Flexcar.) Thus, the total number of CBAM classifications exceeds the total number of informants for the case.

Multiple forms of evidence were collected including interviews, shadowing of first-time Flexcar users, participant observation journals, and source documents (see Table 6.)

TABLE 6. PP+ CASE EVIDENCE

Interviews	Documents	Direct Observation	Participant Observation
Primary: $n = 10$ Secondary: $n =$	$n = 31$	Flexcar user shadowing	TriMet and Flexcar journals

Semi-structured interviews (Appendix E) were conducted with primary informants in accordance with the critical incident technique (Chell, 1998). These interviews lasted an hour and elicited information about turning points leading up to the adoption or discontinuance of transit, car sharing, and bicycle transportation modes. Interviews with primary informants were audio recorded, transcribed, and imported into the Atlas-ti software package for analysis. Contact summary sheets (Appendix H) were written immediately after each interview to preserve initial impressions. A limited number of interviews were also conducted with secondary

informants to obtain background information on the PP+ program. These interviews were audio recorded, but not transcribed or analyzed.

Data collection and analysis were concurrent and conducted in rounds of two or three informants each. As each round of interviews was transcribed and analyzed, new questions emerged which identified new areas for inquiry, prompting another round of data collection and analysis. The first round focused on two transit users. The second round included three former PP+ users. The third round consisted of two potential Flexcar users. The fourth round included three reduced-rate parking users. By the fourth round new categories had ceased to appear from the analysis, indicating that saturation had occurred and that the case was complete. The outcomes are summarized in Table 6.

Direct observation was utilized to shadow two new Flexcar users as they signed up and used the service for the first time. The author also engaged in participant observation by relinquishing car ownership throughout the course of the study, keeping journals on the experience of relying exclusively on transit, bicycle, and Flexcar.

Source documents for the case included mode split data from the PSU Department of Parking and Transportation, newspaper articles, TriMet route maps, and listings of Portland Flexcar locations. Primary informants were asked to complete a short questionnaire (Appendix F) to classify their adoption status according to the Transtheoretical Model. Critical event sheets (Appendix C) were collected during primary informant interviews.

TABLE 7. PP+ PRIMARY INFORMANT OUTCOMES

Round	ID	Summary	Transit	Car Sharing	Bicycle	Annual Pass
1 Transit Adopters	1	Adjunct faculty for several years before becoming full-time; regularly visits elderly mother in an area not well-served by transit	Adopted	Adopted		Adopted
	3	Pursued a variety of modes over several years in hope of reducing the stress of auto commuting	Adopted	Adopted		Adopted
2 Annual Pass Rejectors	4	Bus user who discontinued PP+ in favor of bicycles	Reduced use	Discontinued	Adopted	Discontinued
	5	Light rail user who discontinued PP+ in favor of bicycles	Discontinued	Rejected before 1st use	Adopted	Discontinued
	10	Pursued a variety of modes over several years in hope of reducing the expense of auto commuting	Adopted		Adopted	Discontinued
3 Potential Flexcar Adopters	6	Lifelong transit user	Adopted	Rejected before 1st use	Rejected before 1st use	Adopted
	8	Working mother in one-car suburban family	Adopted	Adopted		Adopted
4 Reduced Rate Parking Adopters	14	Auto commuted for years before discontinuing in favor of transit	Adopted	Adopted	Rejected	Adopted
	17	Suburban worker whose job was transferred downtown	Adopted	Decision pending	Discontinued	Adopted
	18	Pursued a variety of modes over several years in hope of reducing the stress of bus commuting	Discontinued	Discontinued	Rejected before 1st use	Adopted

4.2.2. The Longitudinal Case: Winter Bikes (WB)

The second case was a cohort study of novice winter bicycle commuters. The objective of this case was to trace the progression of the adoption process over time and identify its characteristic states, events, and transition sequences. It was chosen to sample a Svenson Type IV decision requiring active search and construction of alternatives.

Recruiting posters (Appendix A) were posted in bicycle shops, bike-oriented websites, and summer biking events in the Portland area. Telephone prescreening (Appendix B) was used to build a pool of adult informants who were not employed by Portland State University, had made a previous personal commitment to bike to work during the upcoming winter of 2006/2007, had not previously biked to work during the winter, and were relatively inexperienced at riding under rainy, dark, or cold conditions.

Maximum variation sampling was used to solicit informants for a range of personal innovativeness, adoption status, employer size, and geographical distribution throughout the Portland metropolitan area. Innovativeness and adoption status were assessed in the same manner as in the PP+ case. Some informants were recruited from small employers to avoid a potential large-employer sampling bias (many large employers in the Portland area provide some form of transit subsidy.) Finally, since PDOT data reveals that bicycle ridership is lower in hilly Northwest and Southwest Portland than in the flatter North, Northeast, or Southeast parts of the city, informants were sampled to ensure geographic dispersal throughout the Portland metropolitan area. The informant sampling results are listed in Table 8.

TABLE 8. WB CASE INFORMANT SAMPLING

Innovativeness	CBAM Classification		Employer Size	Home Address
1: $n = 0$	0 (Nonuse):	$n = 2$	Size < 50: $n = 3$	SE: $n = 4$
2: $n = 3$	I (Orientation):	$n = 2$		
	II (Preparation):	$n = 0$		N/NE: $n = 4$
3: $n = 1$	III (Situational Use):	$n = 1$	Size > 50: $n = 8$	
4: $n = 5$	IV (Routine Use):	$n = 3$		
	V (Integration):	$n = 2$		NW/SW: $n = 3$
5: $n = 2$	VI (Renewal):	$n = 5$		

To help ensure complete coverage of CBAM states, classification scores were computed for more than one technology (e.g., bicycle and Flexcar.) Thus, the total number of CBAM classifications exceeds the total number of informants for the case.

Multiple forms of evidence were collected for the WB case including interviews, direct observation, participant observation journals, and source documents (see Table 9.)

TABLE 9. WB CASE EVIDENCE

Interviews	Documents	Direct Observation	Participant Observation
Primary: $n = 22$ Secondary: $n = 6$	$n = 54$	PSU Bike Summit	Winter biking journal

Data collection protocols for the WB case were generally similar to the previous case except for the primary informant interviews, which were time-critical. In Portland the winters are cool, dark, and rainy; the rain begins to fall around October 15th and continues almost daily until late spring, offering ideal conditions for a natural experiment (see Figure 21.) Interviewing occurred in two rounds during which all of the informants were interviewed. The pre-treatment round was held in late September 2006 during a two week window just prior to the onset of the rainy season; the protocol for these interviews was substantially similar to the previous case. The post-treatment interviews were held in late February 2007 towards the end of the rainy season, just prior to the return of Daylight Savings Time; the protocol for these interviews was more structured, and the critical event technique was not used (see Appendix E). An interim status check was conducted in early November, and 8 members of the cohort responded by e-mail.

Since the WB case was a cohort study, the outcomes were not known in advance. To help ensure that the data would include examples of discontinuance as well as adoption the informants were told they were under no obligation to keep biking all winter and could continue to participate in the study regardless of their decision. The outcomes for the WB case are summarized in Table 10.

TABLE 10. WB PRIMARY INFORMANT OUTCOMES

ID	Summary	Transit	Bicycle (Pre)	Bicycle (Post)
20	Empty-nester who resumed biking after a pause of many years	Adopted	Adopted	Suspended until spring
21	Took up bike commuting after recovering from major surgery	Reduced use	Adopted	Continuous use
22	Former transit driver who discontinued bus commuting in favor of bicycles	Discontinued	Adopted	Suspended until spring
23	Empty-nester who resumed biking after a pause of many years	Adopted	Adopted	Reduced use
25	Took up bike commuting to economize	Reduced use	Adopted	Continuous use
26	Took up bike commuting for health reasons; struck by car during the treatment period	Discontinued	Adopted	Suspended until spring
27	Took up bike commuting for political reasons; struck by car during the treatment period	Discontinued	Adopted	Suspended until spring
31	Took up bike commuting for political reasons	Adopted	Adopted	Reduced use
33	Took up bike commuting to lose weight	Discontinued	Adopted	Suspended until spring
36	Took up bike commuting to gain exercise	Reduced use	Adopted	Suspended until spring
41	Took up bike commuting to economize	Discontinued	Adopted	Discontinued

4.3. Analytical Approach

As previously noted, data analysis produced two outputs: a theoretical framework and a GAM (see Figure 22.) The theoretical framework was comprised of a grounded theory and a set of sequence diagrams; the GAM was comprised of a structural and behavioral specification.

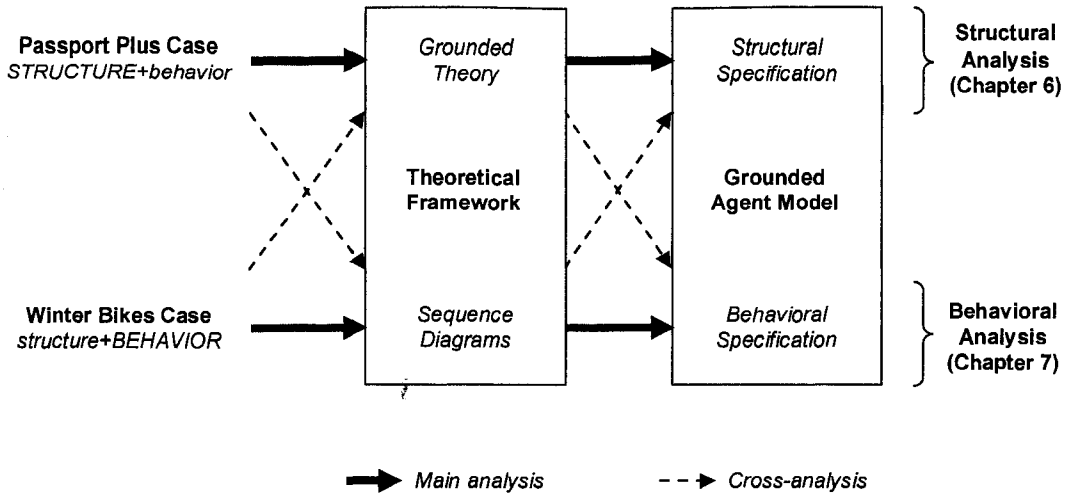


Figure 22. Analytical Approach

4.3.1. Structural Analysis

Grounded theory is a systematic process for induction which produces an emergent theory of a phenomenon in one particular research setting (Strauss & Corbin, 1998). The task of the researcher is to uncover what is going on in that setting by constantly comparing one piece of evidence to another. Data collection began with personal interviews during which the investigator probed for nuances, variations, and connections in the commuting experience.

Open coding was used to break the interview data into discrete chunks to facilitate analysis. The initial template of 77 codes expanded to 97 codes after coding the first interview, and ultimately stabilized at 124 codes in six general groups (see Appendix K for a full listing):

- Commuting issues (e.g., time utilization, cost, accessibility);
- Transportation modes (e.g., rail, bus, car);
- Social interactions (e.g., community building, conflict, socializing);

- Psychological issues (e.g., self-image, regret, behavioral traps);
- Process tags (e.g., candidates, needs, limits…);
- Miscellaneous (e.g., queries, in vivo quotes).

Theoretical memos were produced in parallel with open coding. These were written to explore emergent themes and structured as 'mini-journals' in which each entry was time-stamped to trace the evolution of these themes over time. The two cases yielded a combined total of 160 memos running several hundred pages in length (Appendix M).

As thematic 'categories' began to emerge, they were compared with freshly collected data for refinement into subcategories called 'properties' whose 'dimensions' or ranges of variability could be determined. Grounded theory uses specific and rather idiosyncratic language; Table 2 on page 45 translates grounded theory terms into their UML counterparts.

Axial coding was used to explore the linkage within the categories in the form of conditions, actions/interactions, and consequences. In object-oriented terms, axial coding corresponds to the process of establishing associations and links among the classes. The Atlas-ti qualitative data analysis package was used to conduct axial coding, which produced a series of network diagrams (Appendix N.) Atlas-ti greatly simplified the task of managing and analyzing the large volume of data generated for this study.

A progressive literature search was conducted in parallel with data analysis to serve as a source for making comparisons, enhance sensitivity to nuances in the data,

simulate analytical questions, identify areas for additional theoretical sampling, and compare the emerging framework with prior theory. Late in the analysis a central category was chosen to serve as a vehicle for integration and refinement. Selective coding and illustrative diagrams were then used to communicate the theory. In its final form, the grounded theory consisted of a theoretical framework for adoption whose conceptual elements are presented in Chapter 5.

4.3.2. Behavioral Analysis

Analysis of the behavioral aspects of adoption followed Miles and Huberman's (1994) strategy for sequence analysis, a collection of visual displays which are useful for identifying the causal relationships among a series of events. There were several steps in this analysis.

For each informant:

1. Conduct an interview.
2. Create a chronology of the critical issues (e.g., Table 11.)
3. Convert the chronology into a decision diagram (e.g., Figure 23.)

Then, for each process family:

1. Develop a set of sequence codes (Appendix K and Appendix O.)
2. Code each decision diagram to produce a dataset of sequences.
3. Plot the dataset to create a sequence diagram.

4.3.3. Analysis of Individual Informants

Informant analysis began with the interview. For the PP+ case complete transcripts were produced; transcription for the WB was limited to key *in vivo* passages, since sequence analysis does not require transcripts. Contextual information from each interview was extracted by constructing an issue chronology. This was a two-pass process: during the first pass the audio recording or transcript was reviewed and the issues listed in their order of appearance. A note was made of the approximate time period when the issue was active as well as information identifying the source of the data. During the second pass issues were sorted in chronological order and similar issues consolidated. Table 11 shows a partial chronology for one informant.

TABLE 11. PARTIAL ISSUE CHRONOLOGY FOR INFORMANT #3

Timeline	Issue	Category	Paragraph
Jan 2005	Job interview – found out about PP+/Flexcar link	Functional	5
March 05	Hired at PSU	Functional	29
Spring 05	Dissatisfaction with nonproductive commute time	Personal	129
Spring 05	Feelings of guilt about environmental impact of driving	Personal	129
Spring 05	Concern about potential parking cost	Functional	129, 221
Spring 05	Concern about potential parking hassles	Functional	129, 221
March 05	Decides to participate in PP+	Functional + Personal	29
April 05	Office trip – first use of Flexcar	Functional + Social	37, 133, 163-175, 181
2nd ½ 05	Flexcar billing problems	Functional	201
2nd ½ 05	Forgot to leave keys in Flexcar; got called by service	Functional + Personal + Social	205
2nd ½ 05	Frustration and stress over Flexcar scheduling issues	Functional + Personal + Social	201-207
2nd ½ 05	Limits Flexcar use to essential situations only	Functional + Personal + Social	139, 201-207, 243
2nd ½ 05	Stable pattern of frequent Flexcar use for work errands	Functional	45

Next, the chronology was converted into a decision diagram (DD), a visual display of interactions among streams of issues as a series of decisions unfold over time (Langley, 1999). The purpose of the DD was to depict the time order of events, thus converting nominal data into ordinal data. Figure 23 shows a partial DD for one informant based on the chronology in Table 11. The DD notation is shown in Figure 24. This step yielded a total of 90 pages of DDs: 31 pages from the PP+ case and 59 pages from the WB case. Appendix P contains a complete listing of all DDs.

The bulleted box in Figure 23 is a *selection set*, a stable period during which the informant routinely chose from among a regular set of options anytime the need for transportation arose. Selection sets were especially interesting since their formation and dissolution marked the temporal boundaries of *decision episodes*, the main unit of behavioral analysis.

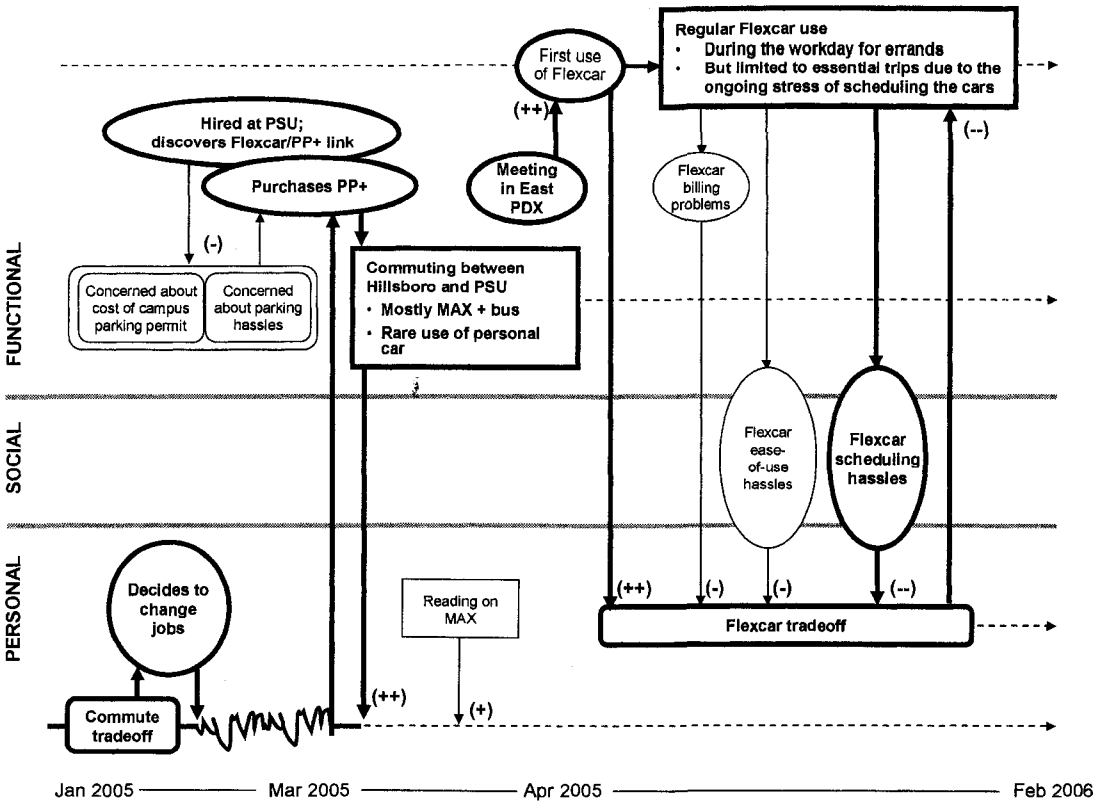


Figure 23. Partial Decision Diagram for Informant #3

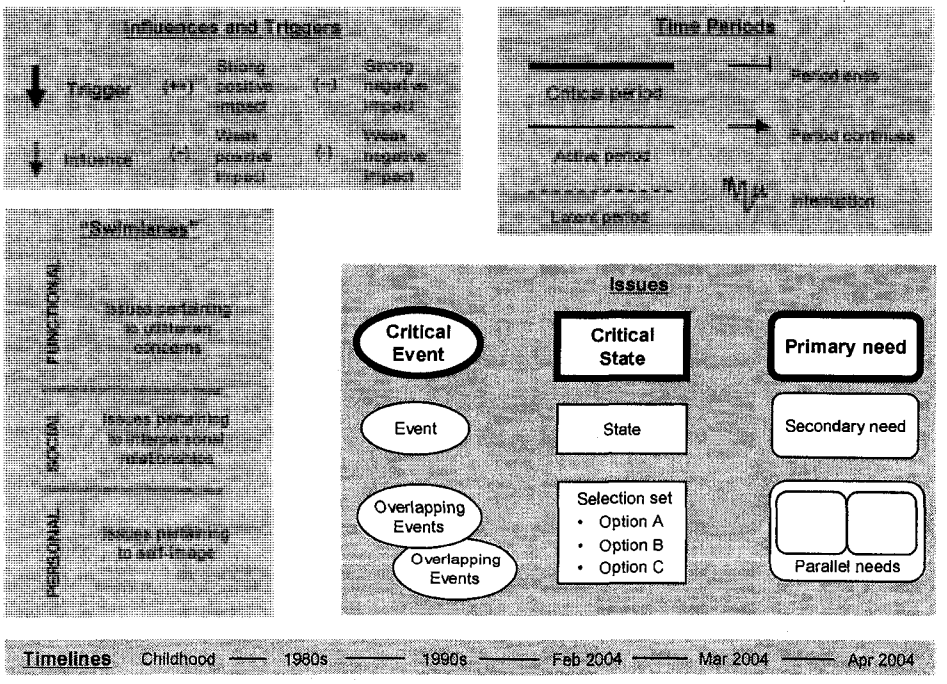


Figure 24. Decision Diagram Notation

At this point member checks were conducted as a validation step (Maxwell, 1996). For the initial PP+ case feedback was solicited from informants whose interviews had raised particularly interesting issues. The DD was used to walk the informants through an account of their decision episodes to uncover errors of fact, interpretation, omission, emphasis, accuracy, or importance. This procedure resulted in only minor corrections to the DDs and was not felt to be entirely satisfactory, since the informants appeared intimidated by the 'formal' appearance of the DDs and may have found them difficult to understand. Furthermore, it was desirable to catch errors at an earlier stage of the process, before effort had been expended to produce the DDs. During the subsequent WB case the procedure was revised to solicit feedback from all informants at the beginning of the second round interview. Instead of the DD, the issue chronology was used to give a verbal synopsis of the decision episodes and solicit informant feedback. This revised procedure proved much more satisfactory and generated better quality feedback at an earlier stage; it also had the added benefit of refreshing the informant's memories at the outset of the second round interviews, thereby eliciting a richer discussion than might have otherwise been the case.

4.3.4. Analysis of Process Families

After completing analysis of individual informants the focus next shifted to analysis of the process families. The first task here was to develop a set of sequence codes for classifying the decision episodes depicted in the DDs. Generating these codes was the most challenging task in the behavioral analysis, since they could not be determined simply through inspection of the DDs; code generation required synthesis

of the chronologies, the DDs, the grounded theory, the progressive literature search, and the GAM. Due to the critical nature of this step the procedure will be described in some detail.

After producing the DDs for the PP+ case a review was made of the grounded theory memos and relevant consumer psychology studies to identify potential process families and sequence codes. A series of three use case diagrams were produced in the StarUML software package: a need-driven adoption path (see Figure 97 in Appendix K), an opportunity-driven adoption path (Figure 98), and a problem-solving adoption path (Figure 99). Use cases are a type of diagram commonly produced at an early stage of object-oriented analysis, when it is important to identify the key actors and functions of a system. The use cases were used to draw up a provisional set of sequence codes; the use cases were then set aside and played no further role in modeling or analysis.

At this point the sequence codes were regarded as initial templates which still needed to be worked out in relation to the data (King, 1998). A few interesting, unusual, or detailed decision episodes were used as test cases. During test coding it was important that resulting sequences did not feel 'forced', which was taken as an indication that the codes had failed to capture some essential feature of the episode. After several iterations the list finally stabilized at 48 codes in three families: 17 evaluation codes, 19 selection codes, 10 maintenance codes, and 2 special interrupt codes (see Appendix O.)

The sequence codes were then used to code all of the DDs. As an illustration of sequence coding, Figure 25 zooms in on an episode from Figure 23 when this informant used Flexcar for the first time.

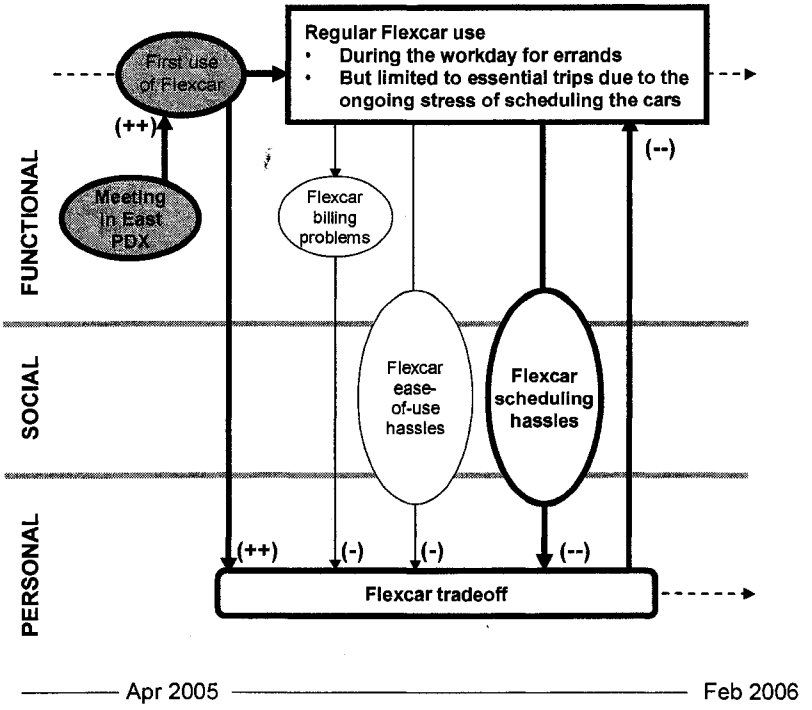


Figure 25. First Selection of Flexcar by Informant #3

Too much detail can clutter a DD and make it unreadable, so during sequence coding it can be helpful to go back and review the original data. From the transcript:

> "My coworkers mentioned that we'd have to leave half an hour early for a meeting right across the river. That prompted me to say 'Oh, maybe there's another way. We could almost walk that fast.' One of them had a car, but she hadn't driven that day. They were talking about riding the bus and how long it would take us to get there, and I said, "Well, I've got the Flexcar, we can just drive over and back." [#3]

This is a typical selection episode. The sequence is:

EVTS FSN AR RCL (Bus) AON SCO RCL (Friend's car) AON SCO RCL (Walk) CLO NO SEN QUITX RSM RCL (Flexcar) AON SCO CLO OO CMT ACT (Flexcar)

To translate: a selection event occurred (EVTS) that resulted in a situation (FSN) needing immediate action (AR). Three options were considered: the bus, a friend's car, and walking. As each option was recalled (RCL), they assessed what would be needed (AON) if they used that option (SCR). Three candidates were all they could come up with (CLO), none of which were entirely satisfactory (NO). Next time they would have to think of something better (SEN), but just now they needed to get to their meeting (QUITX). They were about to resign themselves to a 30 minute bus ride just to cross the river (RSM) when the informant suddenly remembered Flexcar (RCL). This option was quickly assessed (AON SCO) and found to be their best bet (CLO OO). They reserved the Flexcar and drove it to the meeting (CMT ACT).

This first Flexcar use also resulted in an evaluation episode, which was sequenced independently according to the evaluation process codes.

The end product of selection coding was a dataset of 283 sequences in three major families (Appendix O). The final step in behavioral analysis was to diagram and interpret the dataset; the results of this analysis are presented in Chapter 7.

CHAPTER 5. AN OVERVIEW OF THE MTB FRAMEWORK

5.1. Introduction

Chapters 5 through 8 present the motive-technology-belief (MTB) framework, a grounded theory of the TADP derived from a structural and behavioral analysis of the Passport Plus and Winter Bikes evidence. In the MTB framework (Figure 26) the TADP is modeled as a set of structural elements whose interactions are governed by certain conscious and unconscious behavioral processes.

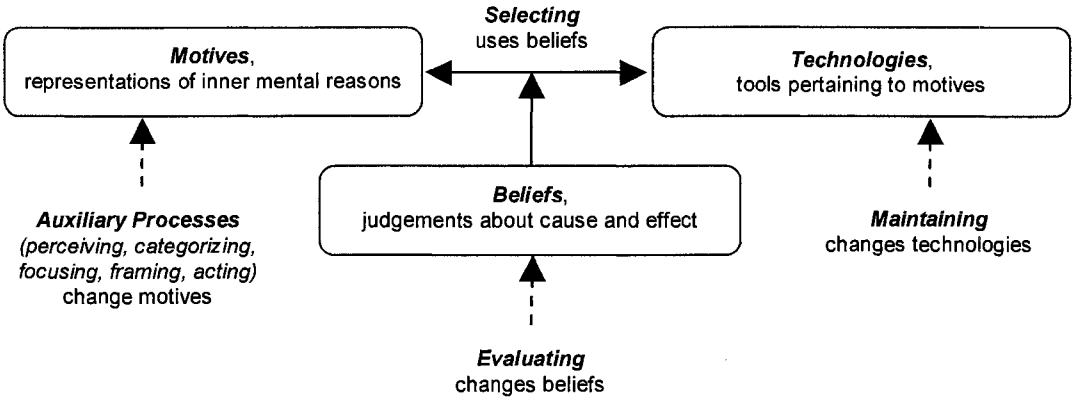


Figure 26. The Motive-Technology-Belief (MTB) Framework

The structural elements are the foundation of the framework; they are analyzed in Chapter 6 using Straussian GT. Structural elements are indicated with nouns:

- A *motive* is a representation of an inner mental reason.
- A *technology* is a tool which pertains to a motive.
- A *belief* is a judgment or attribution about perceived cause and effect.

Behavioral processes operate on the structural elements and are indicated with verbs. Behavioral processes are divided into two groups, conscious and unconscious. In Chapter 7 sequence analysis is used to analyze the conscious behavioral processes:

- *Selecting* is the process of choosing a technology to satisfy a motive.
- *Evaluating* is the process of judging how well a technology satisfies a motive.
- *Maintaining* is the process of ascertaining a technology's functional status.

In Chapter 8 GT is used to analyze the unconscious behavioral processes:

- *Perceiving* is the process of constructing a situational context for an event, assessing its valence (goodness or badness), and attributing its cause.
- *Focusing* is the process of selectively directing attention to certain motives.
- *Framing* is the process of recalling certain motives to memory.
- *Categorizing* is the process of consolidating related motives into summary categories, or differentiating categories into more finely-grained motives.
- *Acting* is the process of implementing a plan.

The MTB framework is a work in progress. Additional validation testing is planned for future research and will doubtless lead to many changes and refinements. Every effort has been made to ensure that the framework is extensible and flexible enough to accommodate change and growth.

5.2. A Comment on UML Notation

Throughout this discussion UML is used to illustrate key relationships; readers are advised to review the short UML tutorial in Appendix I before proceeding. GT and UML terms are considered interchangeable within the context of this discussion and may be substituted without altering the meaning of the framework; Table 2 on page 45 maps GT terms to their UML equivalents. By convention, UML terms are used throughout this discussion to reduce the potential for ambiguity and confusion.

5.3. Analytical Background

This section describes how the MTB framework evolved over the course of the study. My earliest work on the framework began four years prior to the study, when I first began sketching out some ad hoc UML models of the adoption process. I began with the prototype automaton shown in Figure 112 on page 481. The problem I had with this automaton is that I couldn't see any obvious way of validating it; since it sprang from my own imagination and personal insight and was unsupported by any empirical evidence or basis in theory. It was no better than any other staged model. Moreover, it seemed unclear to me what the automaton was a model *of*; in other words, what precisely was the object or unit of analysis whose state changes were being depicted in Figure 112? What were its operational linkages to other processes? What interesting behavior might it be concealing or glossing over? What was happening inside states like "experimentation" and "adoption"? What were the relevant variables and parameters? I wanted to know.

I decided to set the automaton aside and try a different tack. Rather than attempt a deductive validation of an *a priori* model, I would use inductive inquiry to grounded theory of adoption from empirical case studies. I formulated some guiding propositions to serve as an initial framework; these are listed in Appendix Q. During the course of the inquiry I discarded or substantially altered many of these guiding propositions, with three notable exceptions. First, throughout the study I have maintained a broad definition of technology as a tool for extracting power from nature. Second, I have consistently conceived of adoption as a process of forming associations between needs and technologies. Originally I called these associations 'temes' which was suggestive of 'memes'. As the study progressed, however, I concluded that memetics was unworkable as a causal framework, so I changed the name from 'temes' to 'temors'. By the time I formulated the guiding propositions I had realized that Figure 112 was a diagram of state changes in a teme (temor). Third, I have consistently conceived of innovations as structures which emerge from the interactions of needs and technologies. As I see it, innovations have no fixed form, but are historically situated and socially constructed – a stance which is consistent with the tenets of Whitehead's process philosophy (Whitehead, 1929/1978; Rescher, 2000). The reason why innovations are stable over time is because they are generated by universal mental processes – even though the inputs and outputs of these processes vary from observer to observer. I wanted to map out the contours of these processes and capture them in UML form.

As I engaged in field work I allowed the theory to emerge from the evidence, consistent with the Straussian approach to grounded theory. Five themes emerged early on and led to the lines of inquiry traced in Figure 27:

1. Why is thinking hard?
2. Why doesn't everybody adopt?
3. What is a 'perk'?
4. Why do people procrastinate?
5. Why do some technologies have cults?

Several works from decision psychology influenced my thinking, especially Beach and Mitchell's Image Theory (1996), Montgomery and Svenson's contributions to Dominance Structuring (Montgomery, 1983; Montgomery & Svenson, 1983), Svenson and Benthorn's theory of Differentiation and Consolidation (Svenson & Benthorn, 1992) and Irvine's extensions to the Humean theory of motivation (Hume, 1739/1981; Irvine, 2006). Other influences include Regret Theory (Loomes & Sugden, 1982; Dunning & Parpal, 1989), Prospect Theory (Kahneman & Tversky, 1979), the halo effect (Thorndike, 1920; Asch, 1946), Attribution Theory (Kanouse & Hanson, 1972; Miller, Gillen, Schenker, & Radlove, 1973; Orvis, Cunningham, & Kelley, 1975; Miller, 1976; Taylor & Fiske, 1978), Reason-Based Choice (Shafir, Simonson, & Tversky, 1993), the Conflict Model of Decision Making (Janis & Mann, 1977), Norm Theory (Kahneman & Miller, 1986), framing (Tversky & Kahneman, 1981), behavioral traps (Plous, 1993), and Simon's work on bounded rationality, satisficing, and nearly-decomposable systems (Simon, 1956, 1996). These works were extremely

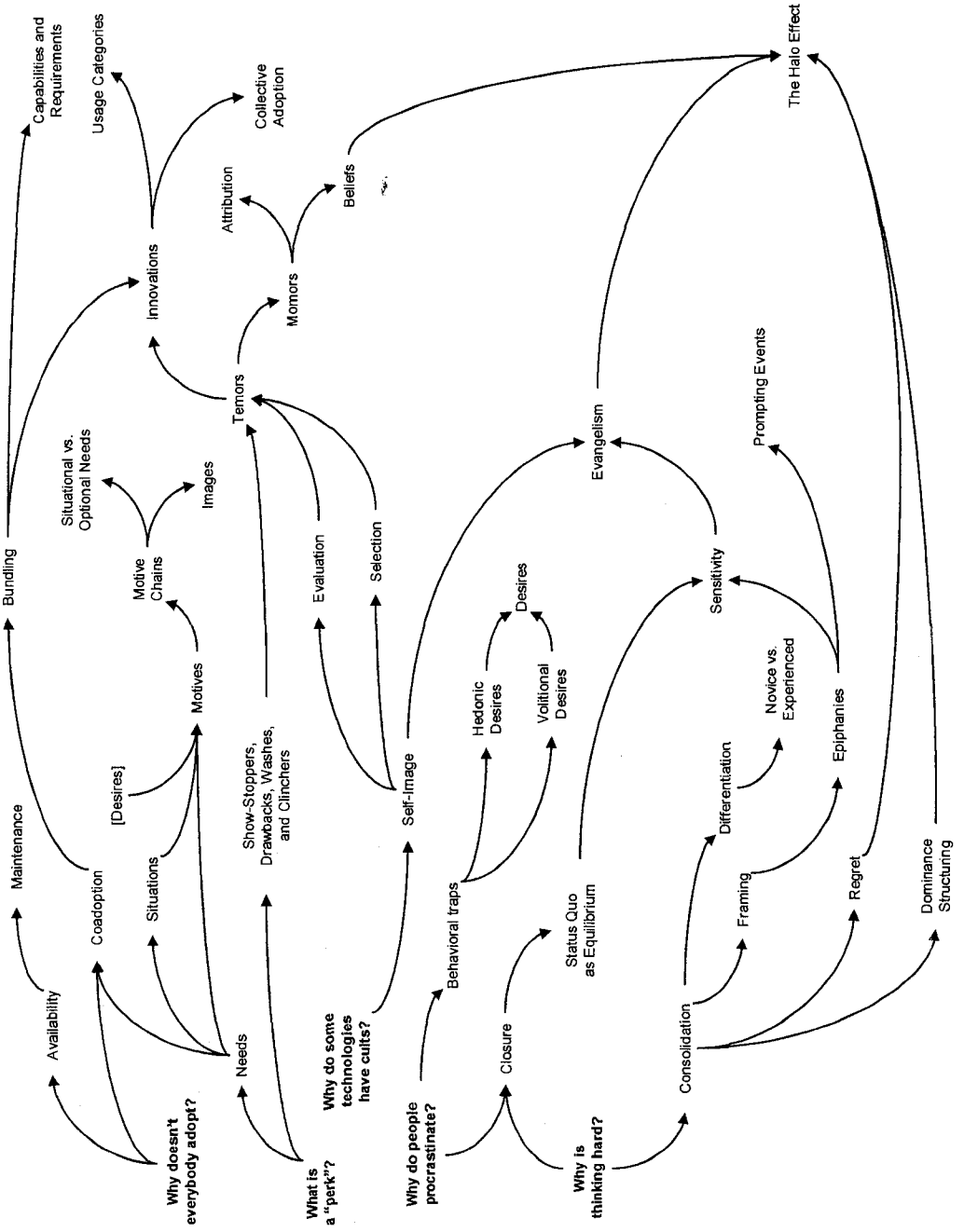


Figure 27. Major Lines of Inquiry

helpful in understanding particular phenomena and achieving a synthesis between the evidence and prior theory.

5.3.1. Why is Thinking Hard?

This is a deceptively simple question. As I see it, most people regard thinking as hard work and will avoid it if they can. This is not meant to be a cynical or perjorative comment; it is offered as an honest assessment of the human condition. Most adoption models treat cognition as a free good, but I disagree: cognition is not free. Our brains consume a large percentage of the calories we take in, and large brains impose other serious drawbacks such as making childbirth more difficult and dangerous and increasing the time needed for a child to reach maturity. It seemed to me that, from an evolutionary standpoint, our cognitive abilities must have been purchased at great cost, and it would be only natural if our brains were wired with various shortcuts to conserve cognitive resources (Gigerenzer, 2000). In particular, people prefer to eliminate uncertainty rather than reduce it (Kahneman & Tversky, 1979; Plous, 1993). Assuming that this tendency arose from the need to reduce cognitive effort, what are the implications for adoption?

A couple of conclusions follow from the observation that people do not like to hold decisions open indefinitely. First, it implies a 'need for closure' (Kruglanski & Webster, 1996) which we experience as an urge to 'get on with it' or 'turn the page' on decisions by reducing complex details into summary categories. Consolidation implies the existence of its obverse, differentiation – learning to recognize nuance and tease fine distinctions from simple initial notions. Inquiry into differentiation led to

examination of what qualitative changes happened as novices gained experience with a new technology.

Another line of inquiry investigated how and under what circumstances collapsing occurs, and how positive and negative information were reconciled to arrive at a summary judgment. This line of questioning explored the phenomena of regret (Loomes & Sugden, 1982) and its opposite, dominance structuring (Montgomery, 1983) better known as 'patting yourself on the back.' Another line of inquiry explored the nature of framing and epiphanies. While examining the need for closure, I realized that the greater weight we accord to negative information sets up the status quo to function as a dynamic equilibrium; an input of energy or 'shock to the system' is required before we will relinquish the old status quo and transition to a new state of affairs. In the data, adoption was always preceded with disenchantment over a rival solution due to a persistent pattern of unmet needs which left the decision maker feeling dissatisfied, exposed, or vulnerable.

5.3.2. Why Doesn't Everybody Adopt?

Most adoption studies have sought to identify factors which encourage adoption and/or reduce the time to adoption. Rogers argues that this has resulted in a systematic 'source bias' in which researchers overidentify with the needs of funding agencies and sponsoring organizations (Rogers, 1987, 2003). Since nonadopters are usually given short shrift by diffusion scholars, the opposite tendency seemed like a fertile area to me: if a technology is so advantageous, then why doesn't everybody adopt?

This line of inquiry led to two insights. The first was that an innovation cannot be used unless it is obtainable, available, and operable when needed; past adoption research has tended to ignore maintenance considerations. Second, bundles of complementary technologies (e.g. walking + transit, or bike + car sharing) are often needed to make up a complete solution, and that from the user's perspective these bundles function as coherent wholes. This led to deeper insights into the basic nature of technologies, including how they provide capabilities and impose additional requirements of their own.

5.3.3. What is a Perk?

I find it curious that I can recognize that an attribute is a perk, and yet I have no idea how I *know* this (or when an attribute is a 'show-stopper', a drawback, a 'clincher', or a 'killer application' for that matter.) How are such 'folk utility' determinations made and used in practice? It seemed to me that these informal idioms were hinting at something important about how decisions are made, and if I understood how they worked I would know a good deal more about adoption. This line of inquiry led to an exploration of needs: what they are, how they manifest themselves in usage situations, from whence they arise, and how they interact. Folk utility is discussed in Appendix R.

5.3.4. Why Do People Procrastinate?

I imagine that I know myself pretty well. Many times when I have decided on a certain course of action – such as removing the tree that is damaging the foundation

of the garage – I can clearly acknowledge to myself that it is the right and proper thing to do and fully resolve to put my plan into action – only to let it languish on my to-do list for weeks, months, or even years. Why do people procrastinate? It seemed to me that this question was saying something important about motivation. A progressive literature search revealed that comparatively little attention had been paid to procrastination except for ways to overcome it. I could locate no studies which explored procrastination as an interesting phenomenon in its own right. During the study I explored the various forms that procrastination takes and the deliberate behavioral traps that informants would set for themselves to overcome its effects (e.g., "New Year's Resolutions"). This line of inquiry improved my understanding of the role that emotions and willpower play in adoption.

5.3.5. Why Do Some Technologies Have Cults?

I find technology cults quite interesting – and, given the central role that word-of-mouth communication plays in technology diffusion, quite an important phenomenon. I was especially curious as to why some technologies like bicycles seemed to encourage vibrant user cultures, whereas others like buses did not. Engaging with informants, I identified several characteristics associated with the growth of user communities, or the lack thereof. This led me to explore how personal and social identities could be constructed around certain technologies (e.g. 'chopper' bikes, tall bikes, 'Zoobombing' and so forth) which in turn increased my appreciation of the role that self-image plays in adoption. Eventually I recognized that evaluating and selecting were distinct mental processes with their own information requirements.

I also explored 'technovangelism' (both pro and con) and the role it plays in reconciling and consolidating conflicting attitudes about technologies.

CHAPTER 6. STRUCTURAL FOUNDATIONS

6.1. Motives

Motives are representations of inner mental reasons. They drive technology use, regardless of whether we are consciously aware of them, deny them, or are able to articulate them – for adoption is not necessarily a rational or consciously planned act: (Levy, 2001)

> "At the time I got the bus pass I didn't have all my transportation issues sorted out. I really didn't even have my PSU schedule sorted out yet. I knew when I would have to be there to teach, but I didn't know when I would be on campus." [#1]

> "I think initially my feeling was, 'Well, I'll ride my bike and see how things go.' I hadn't planned long-term." [#5]

Needs and desires are two subclasses of motives which emerged from the analysis (Figure 28.)

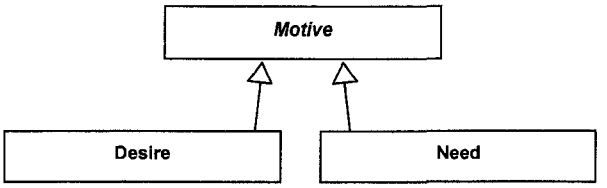


Figure 28. Motives, Needs, and Desires

6.1.1. Needs

Needs are motives which are pursued for the sake of something else, such as when we need A to get B:

> "I thought about Flexcar in terms of having to make a quick getaway from downtown to back home, because public transportation might not be fast enough for emergency situations, because something came up where I needed to be at the house fairly quickly." [#6]

"Parking is a huge issue here; and the cost as well. I think probably the cost was more significant to me than the parking issues, but the cost was going up and up and up. And when the Flexpass was offered at, I think it was first offered at about $17 a month, as opposed to a parking pass which was $70 a month, that seemed completely worth it financially to me." [#14]

Two subclasses of needs which emerged from the data are plans and images.

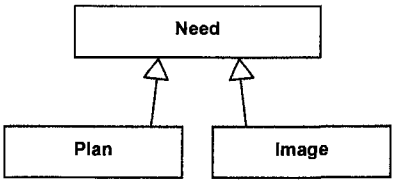


Figure 29. Plans and Images

A *plan* is a short-term, pragmatic need which is conscious in nature:

"I actively made decisions about jobs to take, and what jobs not to take when offered to me, and which jobs to apply for, based on how bad I thought the commute would be. I actually turned down a job south of Wilsonville because it would be too bad a commute. As I said, it also dictated which jobs I was willing to apply for. There were some jobs I felt like I was qualified for and could have gotten, but didn't apply for because I didn't want to travel to those locations." [#3]

"I enjoyed the idea of biking and commuting, and it had been a goal of mine to have the dual purpose of getting exercise while biking, getting to exercise while commuting, like killing two birds with one stone, while working full time." [#10]

An *image* is long-term need that expresses unconscious values of right and wrong, visions of the ideal future, and the trajectory of one's life. Their importance is illustrated by the case of Informant #18, a person with anxieties about riding the bus:

"This whole process [of riding the bus] for me is very personal. The decisions I make about transportation are very different than what another person might make because of specific factors about myself. Such as...my physical size makes it difficult for me. [*#18 is a large person*] So, when I say I want alone time, literally there is some anxiety. I mean, I'm a Chihuahua anyway. But there is some anxiety

about riding the bus. Although I want to...I'm sorry, I'm getting teary. [*#18 is experiencing some strong emotion*] I've had a hard day. Although I want to ride the bus, you've got to understand that it's very tied up with all kinds of other stuff, like...this is probably so weird for you. This comes on the end of a conversation of, 'I just turned 28, I'm trying to get my whole life together, I can't...you know, I'm just learning how to get my garbage out on the right day...' and all this kind of stuff – because I'm kind of a young 28. There is this planning thing with the bus, because the bus requires you to be on time, and I've never been good at that. So it's all very tenuous, my relationship with the bus because it really rubs up against something I'm not very good at. So I can be late in a car, and not feel as bad as if I'm late on the bus. Because I can't make [the bus] go faster, it freaks me out. Or also, I will be on the bus, and it's the #15 and it's really heavily populated, and there's nowhere to sit. Or literally, sitting on the bus is sometimes awkward because there's not a lot of space, or like there's this weird subtle like, 'Don't sit next to me,' or 'God, there's only one seat left and it's her,' and I'm always wanting to share, but sometimes people don't want to sit next to me..." [#18]

As we shall see in Chapter 8, unconscious images are a major driving force for adoption. As Beach and Mitchell argue, "principles cannot be clearly articulated, but they are powerful influences on reasons...potential goals must not contradict them, or those goals and actions will be deemed unacceptable. Moreover, the utility of decision outcomes derives from the degree to which they conform to and enhance the decision maker's values." (Beach & Mitchell, 1996, pg. 3)

6.1.2. Situational and Optional Needs

In the MTB framework, an *episode* is a period of time during which a consumer engages in mental activities relating to technology use. A *situation* is the set of motives which originally prompts or triggers an episode; a *decision frame* is the set of all motives which are active during that episode. Initially, the decision frame and

the situation are identical. Later, motives will be added to or subtracted from the decision frame, causing it to digress from the original situation.

Technologies are never used for their own sake, but are always employed as a means to an end. Thus, the motives in the situation are always needs, and it is useful to refer to them as *situational needs*. Situational needs are the reasons why technologies get used in the first place. For example, we may want to go shopping...

> "The place I lived was unbelievably gorgeous! In the woods! They had redone this place, had this beautiful huge apartment that they had added skylights to in every room. And everywhere I looked, trees and quiet! It was heaven! I was six or seven minutes from Northwest Portland. It was the place that you dream about living, because I was right next to town up there, and...*it was damned.* [Laughs] You couldn't do anything. To get a cup of coffee, or see anyone, I had to get in my car." [#10]

...or attend a meeting...

> "I've been teaching at 4 in the afternoon out in Hillsboro. Sometimes I have a meeting someplace else, or I may need to be here at lunchtime for a faculty meeting or a talk or something." [#5]

...or visit friends or family:

> "I drive to campus maybe once a week, usually if I'm carrying a lot of stuff or if the trip to campus is in conjunction with something else. For instance, I drove to campus yesterday, because when I was through with what I needed to do here on campus I went over to southeast Portland to make dinner for my mom." [#1]

One reason why motives are added to or subtracted from the decision frame is that technology options impose requirements of their own; these are the *optional needs*. For example, we might need to rinse off after biking to work:

> "[Laughs] Physique-wise, I'm not one of the folks who can commute in their work clothes and be presentable at the end of their bike ride. I run

about 10 degrees warmer than everyone else, so I need to clean up when I get where I'm going." [#4]

Some optional needs are not immediately evident, but emerge over time:

"The car commute from Hillsboro to Wilsonville was a huge negative that I really had to work through. I have upper back problems that got worse when I was driving more. It took a lot of my time that couldn't be used for anything else such as reading or anything. Certainly, there was the wear and tear on the car. And I think I put my life at a good deal more risk. There were a number of close calls, and I could see it was just a matter of time before it was going to be not a near miss, but a hit." [#3]

Situational and optional needs are distinguished by the time and manner in which they enter the decision frame. They are not different kinds of needs, like plans or images; they simply enter the decision frame at different times and for different reasons.

6.1.3. Desires

Desires are motives which are pursued for their own sake; they are their own justification and do not depend on other considerations. Two subclasses of desires which emerged from the data are hedonic desires and volitional desires.

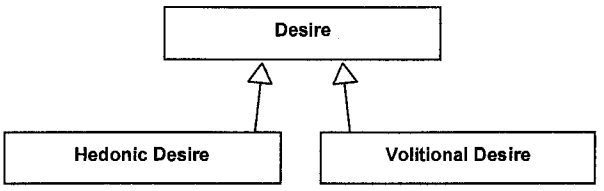


Figure 30. Hedonic and Volitional Desires

Hedonic desires are about seeking rewards and avoiding punishment. They are affective in character and spring from the emotions. For example, fun is its own reward:

> "I just like riding my bike. Not all the time. [Laughs] There are days when I [laughs] come in, you know, you get a bit like a drowned rat, and it's really cold, and you think 'Ah, that wasn't very nice.' But mostly I just enjoy riding my bike. And yesterday, for example, instead of riding my old heavy commuting bike I brought a light racing bike, and I just...it was just a great day. You know, the sun was out, and it just made me feel good about life. So that's why I do it." [#5]

Curiosity is also its own reward:

> "I'm now into month four of being really interested and really into bikes. Being able to get that bike together got me interested in history, and maintenance, and compatibility between different parts, and getting different things together. My obsession for the last few months has been learning more about bikes and getting into cycling more." [#25]

Volitional desires are motives which arise from the will, 'just because'; they are cognitive rather than affective. Volitional desires are not as powerful as hedonic desires and by themselves are not strong enough to motivate adoption:

> "I don't think I would try Flexcar just on a fluke, but I think I would do it if I had a utilitarian reason. I don't imagine I would just go downtown and say, 'Oh, I think I'll just grab one of those Flexcars and buzz around for a while.'" [#1]

Volitional desires are strong enough to tip the balance between opposing hedonic desires, as when we experience a sudden surge of willpower to 'just do it'...

> "The first or second day here at Portland State I noticed that there were a bunch of bikes around, and a couple of people I work with's bikes were there. One of them (at least) lives right down the street from me in North Portland, and I took the emotional leap of just doing it. In the back of my mind it was like 'You could bike that. You can definitely bike that.' But I had this emotional...I just didn't want to think about it, didn't want to deal with it in my own mind. There's the whole, 'Is it going to be safe? It's going to be cold, it's going to be wet. Is your bike good enough? You're going to get hit by a car.' And then, just like the second day I worked here, I was in this moment of change in my life, I was starting a new job. And I just put on my bike clothes, and I biked to work. I just did it." [#10]

Volitional desires can also manifest themselves as determination to see through prior commitments:

> "[Winter bike commuting falls within] the general category of people who do things that they don't necessarily have to, things that are difficult and a challenge. It was impressive [to my coworkers] because somebody has taken a conscious choice to do something that's more difficult than some other alternative." [#25]

Of course, such commitments are not easy to maintain over an extended period:

> "It's kind of like, 'Am I lazy, or am I not?' One of the main discouraging things is, 'Do I really want to ride home in the dark and rain tomorrow night? I don't know." [#25]

'Why not?' and 'Just do it!' are not *rational* arguments, they are *reasonable* ones. Rationality implies suspension of emotion. Reasonability implies the integration of emotion with decision making as an indispensable aspect of wisdom and good judgment. Without our emotions we would lose access to the hedonic desires which comprise the greater part of our motivation and resolve. Noted neuroscientist Antonio Damasio argues that emotions are integral to decision making, a proposal known as the somatic marker hypothesis. He relates the case of Mr. Elliot, a brain-damaged patient who lost access to his emotions and became hyperrational. Mr. Elliot was unable to exercise judgment, form goals, or make tradeoffs, and fell victim to 'analysis paralysis':

> "He needed prompting to get started in the morning and prepare to go to work. Once at work he was unable to manage his time properly; he could not be trusted with a schedule. When the job called for interrupting an activity and turning to another, he might persist nonetheless, seemingly losing sight of his main goal...One might say that Elliot had become irrational concerning the larger frame of

> behavior, which pertained to his main priority, while within the smaller frames of behavior, which pertained to his subsidiary tasks, his actions were unnecessarily detailed...The tragedy of this otherwise healthy and intelligent man was that he was neither stupid nor ignorant, and yet he acted often as if he were. The machinery for his decision making was so flawed that he could no longer be an effective social being. In spite of being confronted with the disastrous results of his decisions, he did not learn from his mistakes." (Damasio, 1994, pg. 36)

6.1.4. Summary

Motives are representations of inner mental reasons: needs are pursued for the sake of something else, whereas desires are pursued for their own sake. Hedonic desires are affective motivations to seek rewards and avoid punishment, while volitional desires are cognitive motivations which arise from the will. Volitional desires are weaker than hedonic desires and not strong enough to drive adoption by themselves; however, they can tip the balance between opposing hedonic desires. Emotions are the driving force behind all technology use.

An episode is a period of time during which a consumer engages in mental activities relating to technology use. Motives that prompt an episode are called situational needs, and motives imposed on the decision frame by technology options are called optional needs. Situational and optional needs enter the decision frame at different times and for different reasons, but they are not different subclasses of needs like plans and images are. Plans are short-term pragmatic needs for achieving particular outcomes. Images are long-term needs which represent fundamental principles of right and wrong, visions of the ideal future, and life trajectories.

The classes of motives discussed in this section form an inheritance hierarchy (Figure 31): a desire is a kind of motive, a hedonic desire is a form of desire, etc.

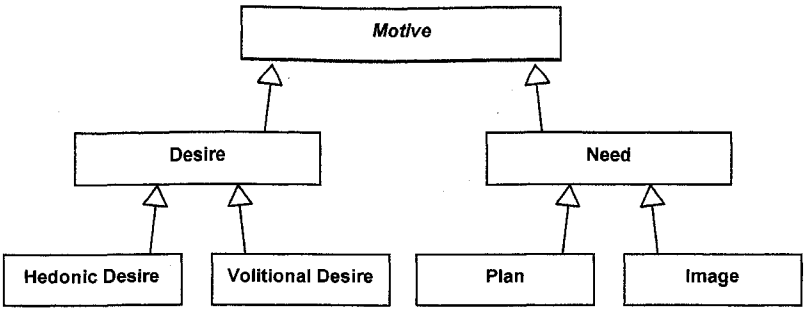


Figure 31. Inheritance Hierarchy for Motives

6.2. Technologies

Technologies are tools that pertain to motives. A technology is simply the name of a category of tool, together with personal knowledge of its properties. Technologies are mental and social constructs which vary from person to person; they are only relevant to adoption to the extent that they help or hinder human purposes.

6.2.1. Capabilities and Requirements

When we speak of using technology A to achieve need B, what we really mean is that we are using some *capability* of A to satisfy some *requirement* of B. For example, a car provides the capability for me to move my self, passengers, and cargo: (Figure 33)

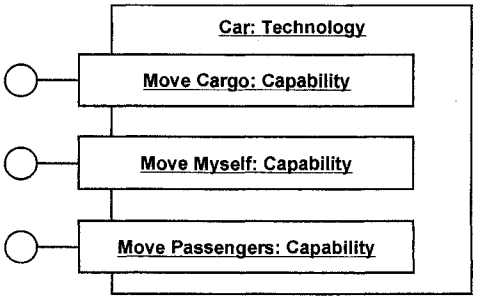


Figure 32. Capabilities

If I need to get to work, I may take advantage of the capability to move myself without necessarily needing to use these other capabilities: (Figure 33)

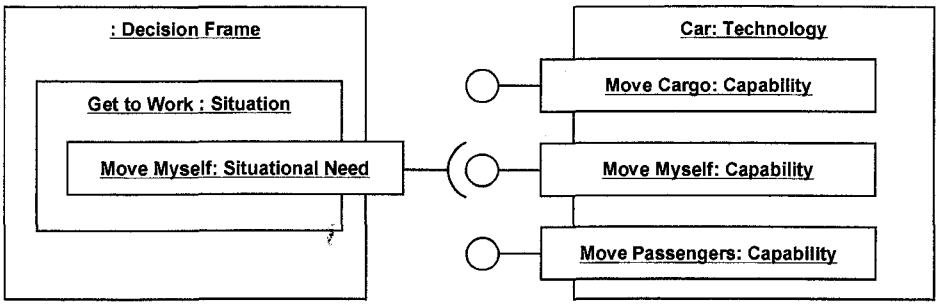


Figure 33. Capabilities and Situational Needs

Technologies impose requirements such as secure storage in the case of a bicycle, fare in the case of transit, and fuel, parking, and a driver in the case of a car: (Figure 34)

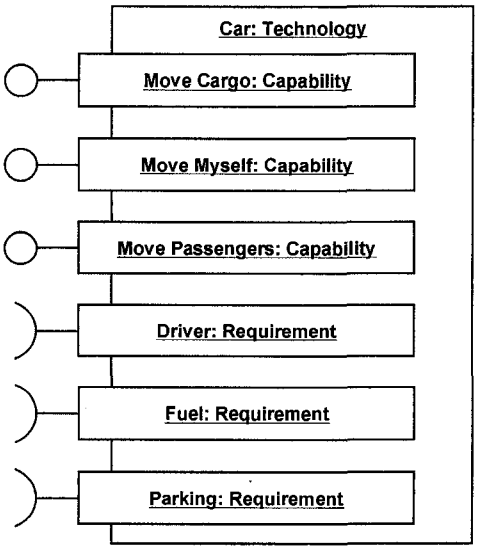


Figure 34. Requirements

Requirements must be satisfied. Using a car imposes optional needs: (Figure 35)

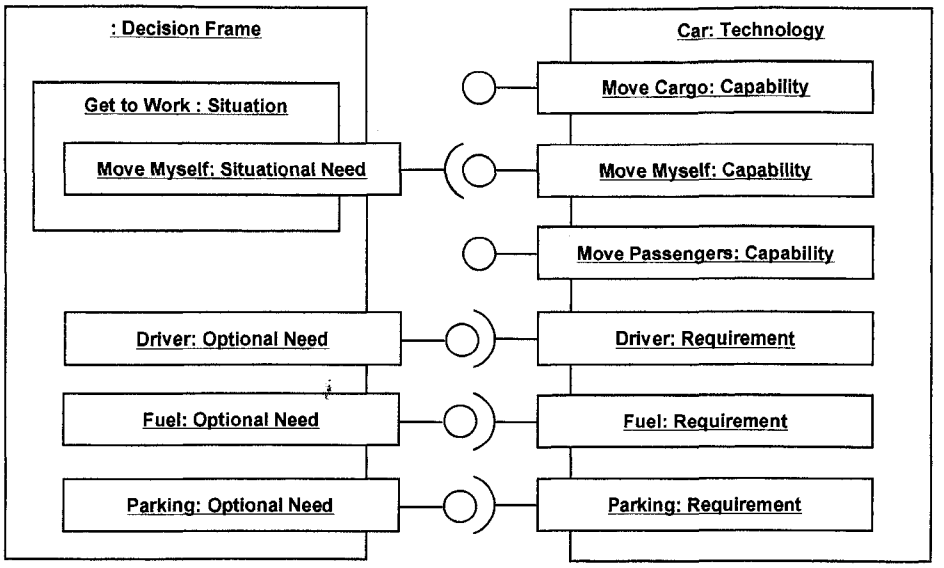


Figure 35. Requirements and Optional Needs

Capabilities and requirements are constructed as technologies and motives are evaluated; thereafter, they are embedded in technologies and motives like raisins in bread dough.

6.2.2. Bundling

Complementary technologies can be combined, such as when a bicycle is bundled with transit to support a car-free lifestyle. For example, informant #21 routinely rides her bicycle to work. Periodically she must travel to her company's headquarters 17 miles northwest of her office in downtown Portland. On these occasions she rides light rail to the station nearest to the headquarters, then bikes the rest of the way. Her "light rail + bike" bundle constitutes a complete solution which acts like a technology in its own right.

Any technology which is capable of being decomposed into potentially useful parts can be thought of as a *bundle*. Bundles are recursive: if a bundle's parts contain

useful subparts then they too may be unbundled, and so forth. For example, a car is a bundle of many different technologies. Its dashboard may contain an analog clock, which is itself a bundle of clock parts. One of these parts is a gear, which may be useful as a spare part, a conversation piece, or hunk of scrap metal:

> There's a couple of chopper bike organizations in the U.S. where folks build tall bikes or chopper bikes. They'll go down to the bins and get a bunch of frames, take them back, cut them up, weld them into new grotesque bike frames, and just ride them around for carnival sorts of things. You'd get on these tall bikes, you know, two frames welded on top, or you'd have a chopper with a 10 foot fork that goes way out in front. They're just goofy machines to ride around on. For different events they'd bring them out and they'd do sort of a show with them. It's called "Chunkathalon." All the tall bikes and chopper bikes get together and compete in different events that involve pretty ridiculous things. So, yeah, there's an ethic of some sort...a cultural aspect." [#4]

Since a gear fragment is not useful as an entity in its own right, a gear is a primitive: it cannot be unbundled, and thus halts the recursion.

6.2.3. The Origin of Capabilities and Requirements

Technologies can sometimes inherit the capabilities and requirements of their bundled subtechnologies. To illustrate, consider the case[1] of a customer shopping for a book online. The customer needs to be able to browse, place and purchase an order, track the order, and ensure the security of his personal information. These situational needs may be satisfied by the technology bundle known as an online bookstore (Figure 36.)

[1] This online shopping example is offered to illustrate the internal dependencies and inheritance mechanisms of capabilities and requirements. It is not meant to be taken as a literal description of e-commerce technology.

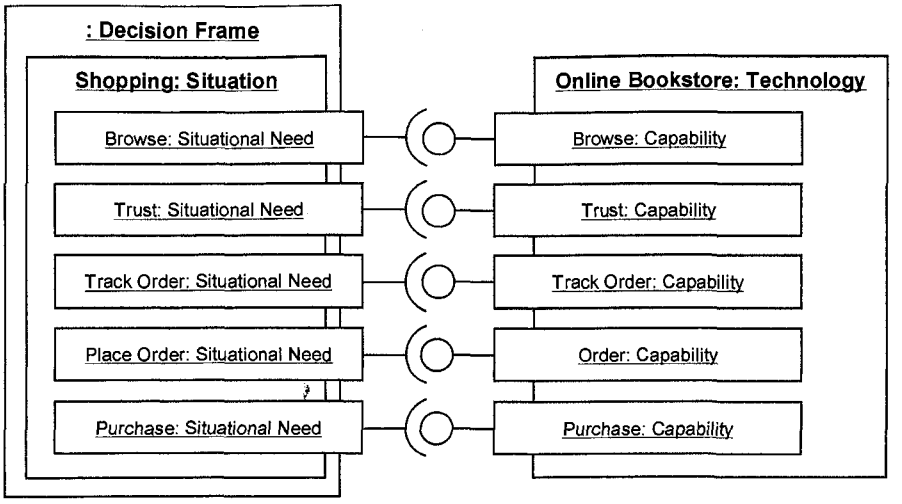


Figure 36. Online Bookstore: Situational Needs and Capabilities

An online bookstore inherits several capabilities from its bundled subtechnologies, as shown in Figure 37. For example, the order tracking capability is inherited from hyperlink technology, and the purchasing capability is inherited from credit card technology.

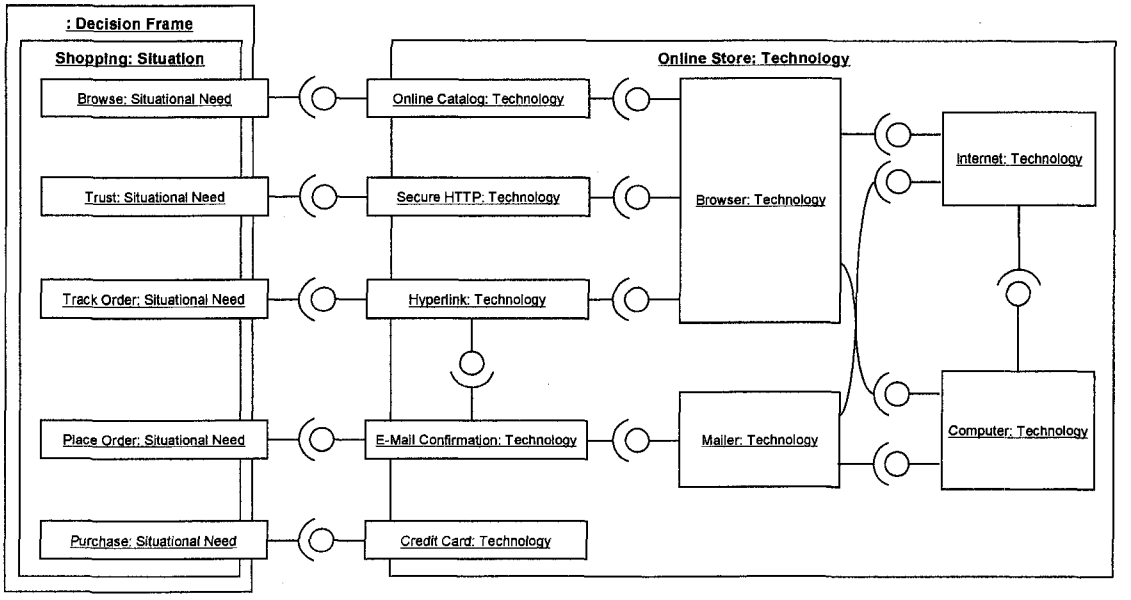


Figure 37. Online Bookstore: Bundling and Internal Dependencies

Figure 37 reveals many internal dependencies; for example, the e-mail confirmation capability requires the hyperlink technology. Because this dependency is satisfied internally, it is transparent and seamless to the user. Because requirements must be satisfied, any internal requirement which is *not* matched by an internal capability will result in a capability deficit, leading to three possible outcomes:

a. One or more of the bundle's external capabilities will be lost, a condition familiarly known as a 'show-stopper'.

b. The deficit will be imposed as an external requirement on the customer, adding one or more optional needs to the decision frame. This condition is informally known as a 'drawback.'

c. The deficit will be imposed as an external requirement on some exogenous technology, resulting in a new bundle. Over time, technologies within a bundle may become optimized to each other's presence, which tightens the bundle's internal constraints to such an extent that the subtechnologies are no longer capable of functioning independently. They have become primitives.

In online shopping the browser, mailer, internet, and computer are not provided; they are imposed as external requirements on the customer, and thus add new optional needs to the decision frame (Figure 38.)

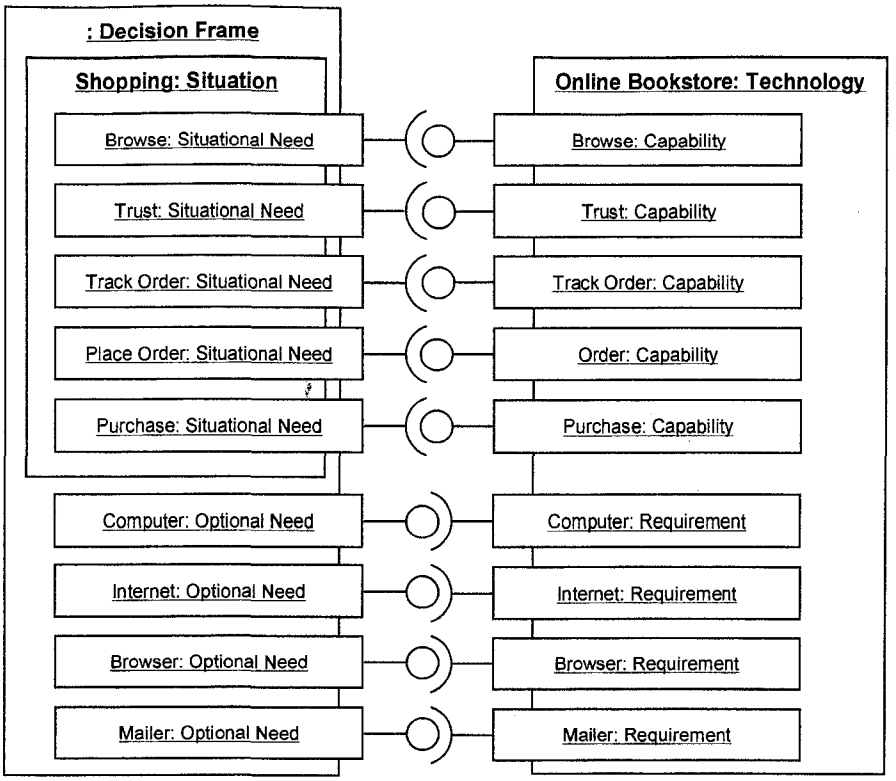


Figure 38. Online Bookstore: Requirements and Optional Needs

In the MTB framework technologies do not exist 'out there' – they are mental and social constructs which reside in the mind of the user, consistent with the tenets of Whitehead's process philosophy (1929/1978). It follows that capabilities and requirements do not exist 'out there' any more than technologies do: as we shall see in the next chapter, they are constructed during the evaluating process, used during the selecting process, and changed during the maintaining process.

6.2.4. Summary

Technologies are tools which pertain to motives. A technology is the name of a category, together with the knowledge of its properties. Knowledge about technologies

is mentally and socially constructed; it varies from person to person and culture to culture.

Technologies have capabilities and requirements. Capabilities satisfy needs or requirements, whereas requirements impose conditions which must be satisfied. Capabilities and requirements are constructed as technologies and motives are evaluated.

Technologies encapsulate various subtechnologies through recursive bundling; a technology may be unbundled as long as at least one of its subtechnologies is capable of satisfying a need on its own. Technologies which cannot be unbundled are said to be primitives.

6.3. Beliefs

Beliefs are judgments or attributions about perceived cause and effect which we construct as we evaluate technologies and motives; beliefs do not have independent existence. Beliefs are not reflexive; just because I believe that A satisfies B does not imply I believe that B satisfies A. This property is called *valence*:

- Positive valence: A is effective at satisfying B.
- Negative valence: A is ineffective at satisfying B.
- Mixed valence: A partly satisfies B.
- Unknown valence: It has not yet been determined whether A satisfies B.

Every belief has two endpoints: a requirement or "effective" end in which something is wanted, and a capability or "causal" end in which something is provided.

A belief, then, is comprised of a requirement end, a capability end, and a valence property. We can express this structure in UML form (Figure 39.)

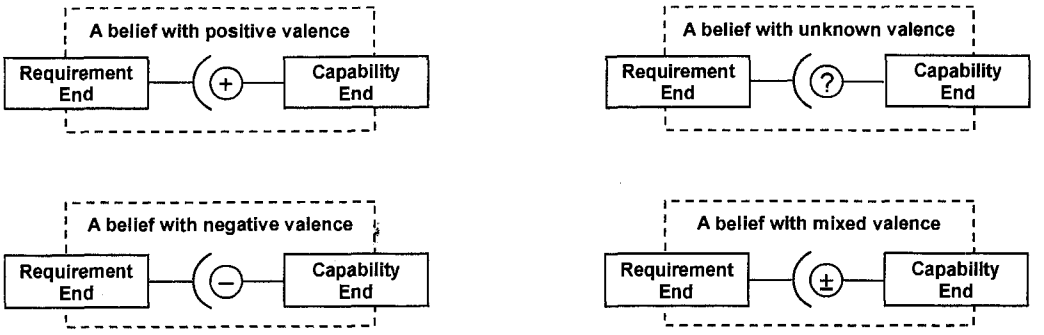


Figure 39. The Internal Structure of a Belief

Requirements and capabilities act like 'sockets' and 'pegs' to join motives, technologies, and beliefs; they are the internal interfaces of the MTB framework.

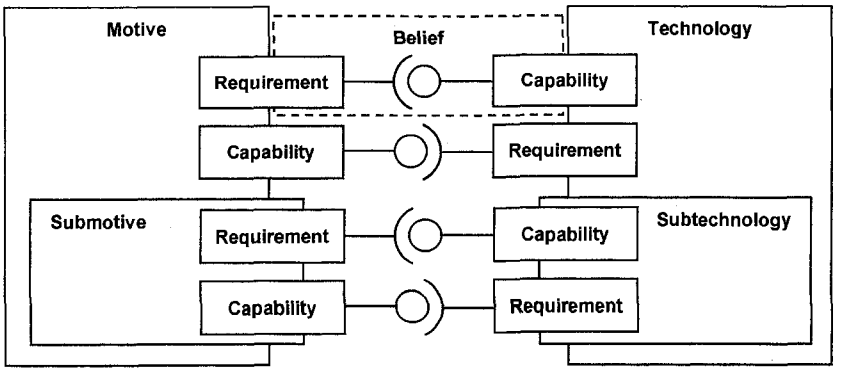


Figure 40. Capabilities and Requirements in the MTB Framework

It is hypothesized that the process of evaluating a technology differs from the process of evaluating a motive. Identical processes would imply that there is no difference between abstract and concrete thought, and that ideas and innovations are fully equivalent. Studies from developmental psychology contradict this implication. In a series of experiments, Piaget demonstrated that children develop cognitive abilities in stages, and that their ability to manipulate concrete objects precedes their ability to grasp abstract ideas (Benson, 1998). While far from conclusive, such

evidence suggests that beliefs have physiological counterparts in the brain which develop at different rates, and that beliefs about physical objects differ from beliefs about abstract ideas in ways that are yet to be determined. If true, this hypothesis implies the existence of two subclasses of belief, which it is useful to call temors and momors (Figure 41.)

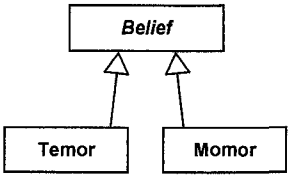


Figure 41. Inheritance Hierarchy for Beliefs

6.3.1. Temors

A *temor* (for 'technology-motive relation') is a belief which relates a motive to a technology; it serves as a home for the properties of a single dimension of technology use. Figure 42 gives an example of a temor. Temors are discussed in Chapter 7.

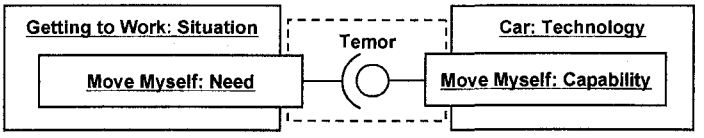


Figure 42. Temors

6.3.2. Momors

A *momor* (for 'motive-motive relation') is a belief which relates one motive to another; it serves as a home for the properties of that association. Figure 43 gives an example of a momor. Momors are discussed in Chapter 8.

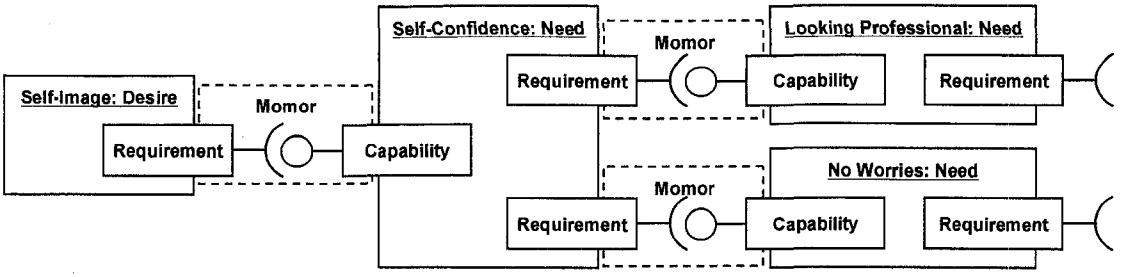


Figure 43. Momors and Motive Chains

6.4. Chapter Summary

This chapter introduced motives, technologies, and beliefs, the structural foundations of the MTB framework. It defined two subclasses of motives (needs and desires), two subclasses of desires (hedonic and volitional), and two subclasses of needs (plans and images.) Situational and optional needs differ by the time and manner in which they enter the decision frame, but they are not different types of needs.

Technologies are tools that pertain to motives. They are mental and social constructs, so their precise definition will vary from person to person and culture to culture. Technologies have various capabilities and requirements which they can inherit from their bundled subtechnologies.

Beliefs are attributions of perceived cause and effect. Two subclasses of beliefs are temors (relations between motives and technologies) and momors (relations between motives.)

Table 12 traces these structures back to their origins in the analytical memos and network diagrams, and from there they may be traced back to the empirical

evidence. The full text of all theoretically significant memos is contained in Appendix M; the network diagrams are shown in Appendix N.

TABLE 12. TRACEABILITY MATRIX FOR CHAPTER 6

Topic	Memo (Appendix M)	Network Diagram (Appendix N)
Motives	M.45	N.11
Needs	M.45	N.11
Situational and optional needs	M.45, M.50, M.51	N.1, N.3, N.2, N.11
Desires	M.20, M.45	N.6, N.11
Hedonic desires	M.10, M.32, M.45	N.1, N.2, N.8, N.9, N.10, N.11
Volitional desires	M.10, M.43, M.45, M.54, M.70, M.68	N.1, N.2, N.3, N.6, N.7, N.9, N.10, N.12
Technologies	M.18	N.4, N.5
Bundling	M.46	N.12
Capabilities and Requirements	M.45, M.50, M.51	N.1, N.3, N.2, N.11
Beliefs	M.33, M.39, M.45, M.52	N.2, N.7, N.8, N.10, N.11
Temors and Momors	M.45, M.56, M.62	N.11, N.12

CHAPTER 7. CONSCIOUS BEHAVIORAL PROCESSES

This chapter discusses the conscious behavioral aspects of the MTB framework. Sequence analysis was used to identify and map the behavior of three processes: selecting, evaluating, and maintaining.

7.1. Selecting

Selecting is the process of choosing a technology to satisfy an immediate need. Of the 283 identified behavioral sequences, 75 (27%) involved selecting. These are plotted in Figure 44.

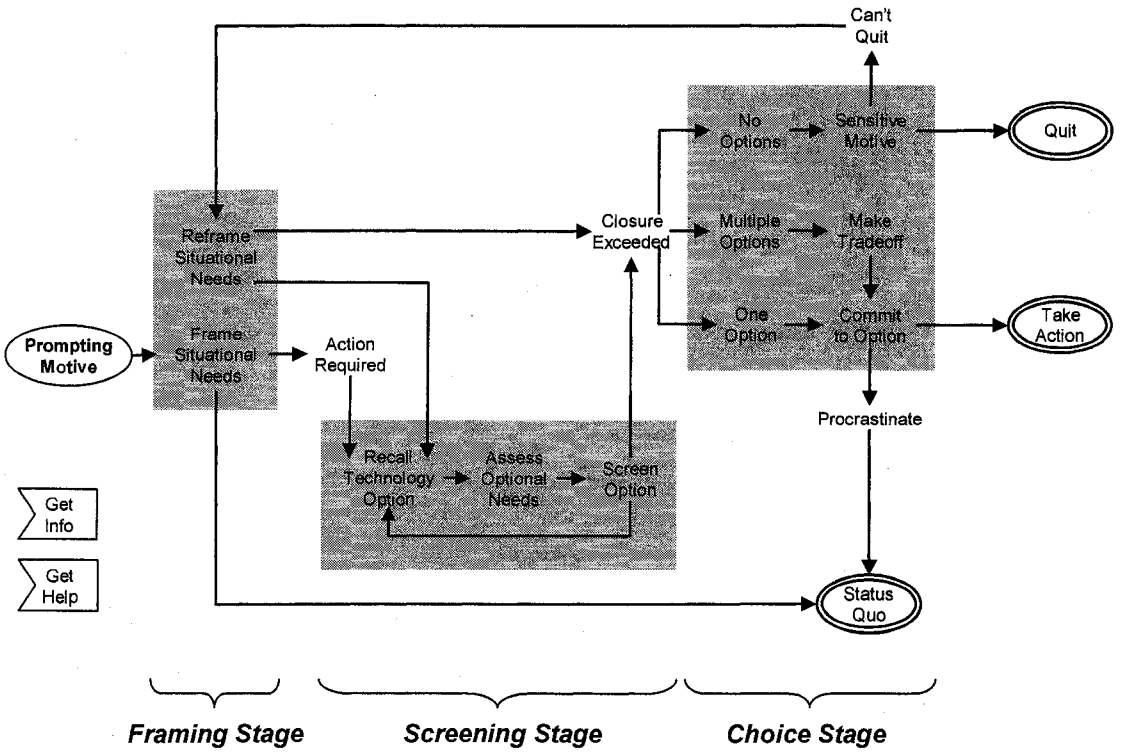


Figure 44. Sequence Plot for the Selecting Process (n = 75)

Selecting unfolds in three stages: framing, screening, and choice (c.f. Beach & Mitchell, 1996). *Stages* are sequences of conceptually related tasks. They are characteristic of simple behavior in which a series of tasks is performed until the series is completed or the tasks are interrupted by an external stimulus (Douglass, 2004). Simple behaviors are not reentrant, so if they are interrupted they cannot be resumed; they must be restarted at the beginning.

7.1.1. The Framing Stage

During the framing stage the decision maker assesses the situation to determine whether action is warranted. This stage makes use of an unconscious auxiliary process of the same name which is discussed in the next chapter.

Every selecting sequence was initiated by a prompting motive of some sort. Most involved the need to commute to work, but a few were prompted by other needs such as socializing with friends and family, shopping, child care, and family emergencies. The exit criteria for this stage is whether the situation is considered pressing enough to merit attention at present; this determination involves an unconscious process called focusing which is discussed in the next chapter. Figure 45 depicts the framing stage in the form of a UML activity diagram.

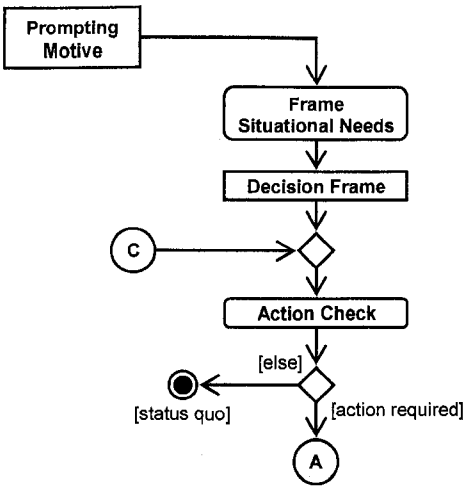


Figure 45. The Framing Stage of the Selecting Process

7.1.2. The Screening Stage

During the screening stage the decision maker assembles a short list of viable options that might satisfy the needs of the situation. If the situation is a familiar habit, the list could be as short as a single option. As each option is recalled, its capabilities and requirements are screened for compatibility with the situational needs. Screening concludes when the decision maker judges that enough effort has been spent reviewing the options and that it is time to make a choice. This determination is called closure, part of the acting process discussed in the next chapter. Figure 46 depicts the screening stage in UML form.

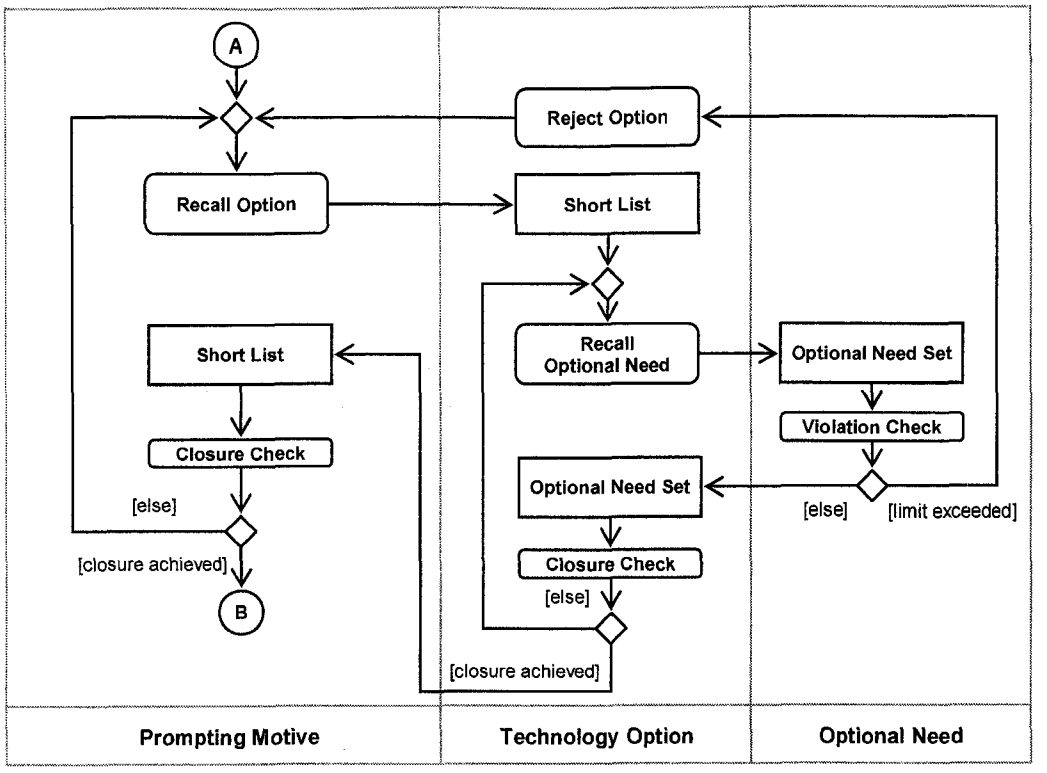


Figure 46. The Screening Stage of the Selecting Process

7.1.3. The Choice Stage

During the choice stage the decision maker picks a finalist from the short list of screened options. There are three potential paths through this stage depending on how many options there are in the short list. If there is more than one option, the decision maker must expend cognitive effort to make a tradeoff:

> I was thinking, 'How am I going to get to PSU?' My daughter was also working downtown, and she's always complaining about how she had to commute, and how bad the traffic is, and there's nowhere to park, and it's so expensive. So the solution to me was clear: I'll ride my bike, most of the time, because that's how I commuted to my last job. But that was only three miles from home; this is twelve miles from home, and it's over the top of the hill. This was okay for the first few trips in September, when the weather's good, and I haven't got a tight schedule to meet. When we did the employee orientation, and the realities of coming in everyday and having to be in on time to teach classes and so forth came along, I thought 'Well, the TriMet pass looks like a good

> option. I can ride my bike to the Sunset Transit Center. I can get on the train which takes me right to Goose Hollow, and then it's only something like another five minute's ride from there to here, this seems like a good way to get to work.' So I signed up for the TriMet pass. [#5]
>
> If it was just car versus MAX, there would have been no question about it, but there's the solid third option for me, the bike. Because I also get exercise. I mean, the recorder can't see this, but I have a few extra pounds on me, and I sit at a desk for a third to half of my day. I have the long-term intention of getting more exercise, and biking is good, low-impact, get-fresh-air exercise. [#10]
>
> We actually bought a new car in August of '04, to replace the old vehicle. We sat down and did the math beforehand, and thought about the cost of using rental cars, the cost of using Flexcar. At the same time, unfortunately, my wife moved to a new work location that's not served by transit very well. So, it made sense to buy. [#4]

There is a considerable body of literature on tradeoff heuristics; for reviews, see Payne, Bettman, and Johnson (1992) and Gigerenzer (2000).

If there are no options in the short list the prompting motive becomes sensitized, an aspect of focusing discussed in Chapter 8. As indicated by Figure 44 on page 140, the decision maker can either give up at this point or settle for less by reframing the situation:

> Public transportation takes effort in the sense of being willing to spend more time, being willing to wait; being willing to accept the compromise of 'Oh, other people have to get out on this stop!' Sometimes when I ride the #19 out I regret the decision, because it stops and it starts... 'Why do these people have to get out here? Go straight ahead!' I like the idea of an express bus. I always use to say with the #12, 'Why the hell don't they have an express line for the #12 line?' There's a certain inconvenience, and with a bus you're lurching around a bit, too. I guess the universe does not revolve around me, and I guess public transportation – it's fairly obvious that you're making some compromises. [#6]

There are two paths forward from reframing. The first is to cancel or deemphasize some of the needs in the decision frame (Kahneman & Tversky, 1979; Montgomery, 1983) in such a way as to qualify at least one option for the short list; flow then returns to the choice stage for a resolution. The second path is to 'think outside the box' or have an epiphany by recalling an infrequently used or untried option. Flow then proceeds to the screening stage where the viability of the option is checked.

Assuming that the decision maker does not quit, the choice stage concludes when exactly one option remains and the consumer commits to a course of action. However, commitment does not guarantee implementation, for the decision maker may still procrastinate; this process is discussed in Chapter 8. Figure 47 depicts the choice stage as a UML activity diagram.

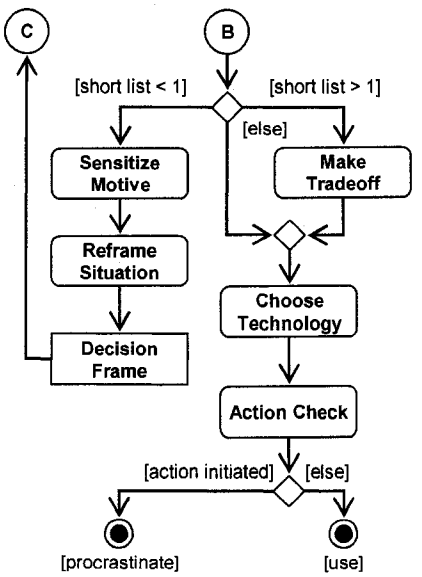


Figure 47. The Choice Stage of the Selecting Process

7.1.4. Help and Information Events

Thus far we have not considered what happens when selecting is interrupted. Two interrupt events were observed in the behavioral data: gaining help from other persons and gaining new information. We do not distinguish whether such events were initiated by the decision maker or by someone else. Help and information events are asynchronous and may interrupt the selecting process at any time; in so doing, they provide an operational link to the evaluating process as we shall see in the next section.

The behavioral data indicate that novice users are more likely to acquire new information during the screening stage as they assess the optional needs of a new technology. They are more likely to acquire help during the choice stage, just after committing to an untried technology but prior to implementation. No regularities were observed in the help or information events of experienced users. Figure 47 depicts these events as UML interrupt handlers.

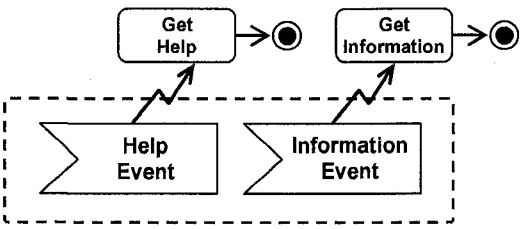


Figure 48. Interrupt Handlers for the Selecting Process

7.1.5. Discussion and Summary

Selecting is the process of choosing a technology to satisfy an immediate need. Its main input is a prompting motive, and its main output is technology option. Selecting is an operation of the need class.

The hypothesis that selecting is a simple behavior is supported by two lines of evidence. First, if selecting were a simple behavior we would expect it to unfold in stages. The sequence data revealed three of these – framing, screening, and choice – which are congruent with other staged adoption models, especially Beach and Mitchell (1996). Second, if selecting were a simple behavior then we would expect that decision makers would respond to interruptions by starting the process over from the beginning. This hypothesis is supported by an experimental study by Potter and Beach (1994) which asked subjects to screen a list of apartments. After the subjects had produced a short list they were informed that all of their options had been rented and were no longer available. Subjects were then given the option of screening an entirely new set of options or rescreening their previously rejected options. Potter and Beach found that nearly 90% of the subjects preferred starting over with a new list of rooms, consistent with the hypothesis that selecting is a simple behavior.

In summary, selecting is a simple behavior which requires the decision maker to maintain a train of thought. While selecting is a conscious process[2], the cycles in Figure 44 indicate that it is not a simple linear progression of stages. Selecting is 'reasonable' in the sense that it is involved in constructing defensible 'reasons' or narrative justifications for decisions. However, selecting is supported by a number of unconscious auxiliary processes, which belies the notion that it is entirely rational. Figure 49 summarizes the entire process in UML form.

[2] For Svenson Type III and IV decisions, at any rate.

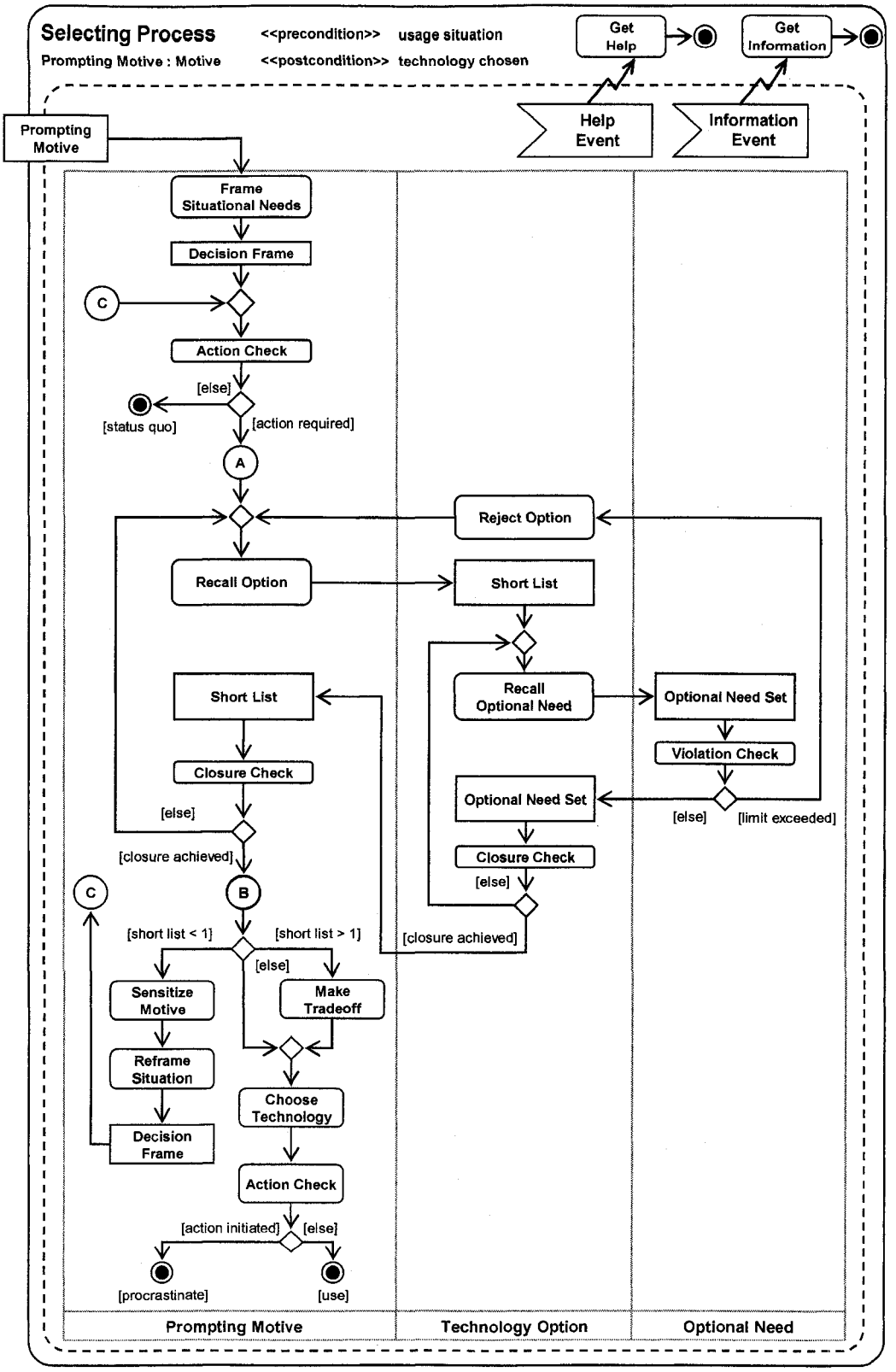


Figure 49. The Selecting Process (Need Class)

7.2. Evaluating

Evaluating is the process of assessing how well a technology satisfies a motive. It accounts for 151 of the 283 sequences (53%); these are plotted in Figure 50.

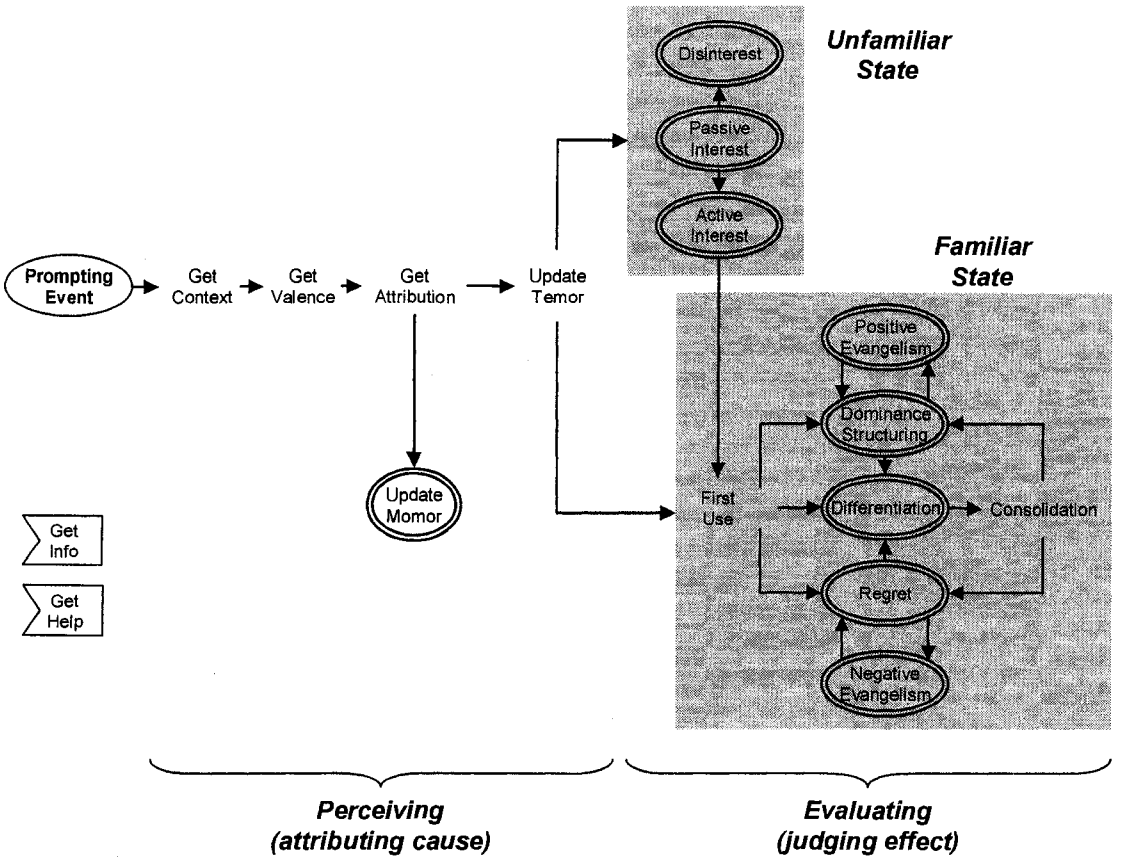


Figure 50. Sequence Plot for the Evaluating Process (n = 151)

Evaluating is an operation of the temor class. Each temor preserves the state of a single motive-technology pair, and evaluating is the main process by which that state changes. Each temor is judged on its own merits: a technology that is unsatisfactory for one motive may be quite satisfactory for another. However, the temors of a motive are not truly independent. They are only 'nearly decomposable' (Simon, 1996) in that they can influence each other to change states by means of the unconscious 'halo

effect' discussed in Chapter 8. Thus, evaluating is not the only way for temors to change states.

Evaluating is an event-driven behavior characterized by fault lines or axes which bifurcate the temor state-space into mutually exclusive substates. For each axis there exists a characteristic event that induces a transition from one state to the next. The axes for the evaluating process are:

Relevance: Is this technology relevant to this motive?

Familiarity: Have I ever before used this technology to satisfy this motive?

Valence: Is this technology of positive, negative, mixed, or unknown worth in terms of satisfying this motive?

A *state* is a period of time during which a condition is satisfied or an event is pending; states differ from stages in certain ways. For example, a light switch has states: at any given time it is either on or off, and the transition from one state to another is discrete and instantaneous. By contrast, stages flow from one to the next in a steady progression. A party is thrown in stages: planning the guest list; sending invitations; making preparations; greeting the guests; partying; and cleaning up. Information flows between stages, but it does not flow between states.

7.2.1. The Relevance Axis

Before an event can be evaluated it must first be recognized as relevant. Every evaluating sequence began with a prompting event of some kind, such as an interesting news item, a surprising experience, a chance opportunity, a sale or special

offer, or an otherwise noteworthy incident. While all of these events involved technologies, their cause was not always attributed to these technologies. In many cases cause was attributed to human actors or chance circumstances:

> "I saw a bus pass by, but it didn't occur to me that that was a mode of transportation. That's what surprised me when I got on the bus in Eugene – the internal experience of 'Oh, this is a mode of transportation. This is a *real* mode, it's not a theoretical mode of transportation. It's almost like a train.' I've only taken a train in Europe, maybe once in the States. It was an incredibly pleasant experience. But I don't think of it as transportation; it's almost like a little holiday, like scuba diving or something." [#10]

Attribution is an aspect of perceiving, an unconscious auxiliary process which always precedes evaluating. Perceiving constructs a situational context for an event, assesses its valence (goodness or badness), and attributes its cause. Events which are attributed to technological causes are routed to the appropriate temor(s) for evaluating; otherwise they are routed to destinations outside the scope of the framework. Perceiving is discussed in Chapter 8.

Relevance (Figure 51) is an axis which divides the temor state-space into the irrelevant and relevant substates. When a temor is in the irrelevant state it means that the technology has no bearing on the motive (e.g., canning is irrelevant to commuting.) A temor in the irrelevant state will ignore any event except recognition that the technology is relevant to the motive.

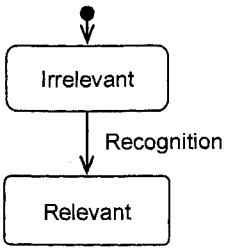


Figure 51. The Relevance Axis

7.2.2. The Familiarity Axis

The first occasion of use is a watershed event:

> "I very distinctly remember [the first time I rode MAX to work.] The level of stress and driving was just completely removed. I remember thinking, 'I can't believe I drove on the Banfield for 25 years!' Because I've been at PSU, it will be 29 years in August. And every day I drove. I just remember, just the level of...[exhales] ah! just *relaxation*, sitting on the MAX, instead of sitting in traffic gripping the steering wheel. And I had no idea, the level of stress I had sitting on the freeway, until I sat on the MAX. And that first week I so clearly remember how less stressed I was when I got to work. So, that was pretty significant for me." [#14]

First use divides the adoption experience into before and after, novice and experienced, unfamiliar and familiar. A recent experimental study found significant differences in the perception of product capability and usability between novice and experienced users; these same differences were not observed among amateur and expert subjects (Thompson, Hamilton, & Rust, 2005). The first tacit experience with a product changes evaluation in a way that explicit expertise does not.

Familiarity (Figure 52) is the second axis of evaluating. This axis is only defined while the temor is in the relevant state. The first use event bifurcates the relevant state into two substates: unfamiliar and familiar.

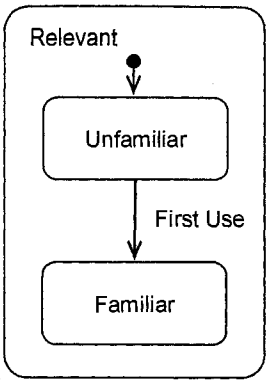


Figure 52. The Familiarity Axis

7.2.3. The Valence Axis

Valence is the third axis of evaluating; it refers to the worth of a technology in satisfying a need. Like the other axes, valence is dichotomous: a technology either satisfies a need or it does not, there are no 'in-between' values. What we think of as 'in-between' value is actually caused by enhanced perception of need. As we gain experience in using a tool, we often find that our needs are more complicated than we originally thought. We develop a more refined and nuanced understanding of our needs in parallel with a finer appreciation of which tools are right for the job: for ordinary household maintenance I can make do with a hammer and a screwdriver, but a professional carpenter cannot. Thus, mixed valence does not indicate an intermediate value between positive and negative valence; it indicates that a need is complex and must be unpacked before it is possible to say whether or not an option is satisfactory. Is a hammer satisfactory for building a cabinet? The answer will depend on which task is being performed. A temor with mixed valence can always be unpacked or differentiated into a more refined set of temors with dichotomous positive or negative valence. The differentiating process is discussed in Chapter 8.

We begin to develop beliefs about the worth of an option even before we have tried it. When discussing the valence axis it is important to distinguish between its effects in the unfamiliar and familiar states.

7.2.4. Valence in the Unfamiliar State

The valence axis (Figure 53) divides the unfamiliar state into the passive interest, active interest, and disinterest substates.

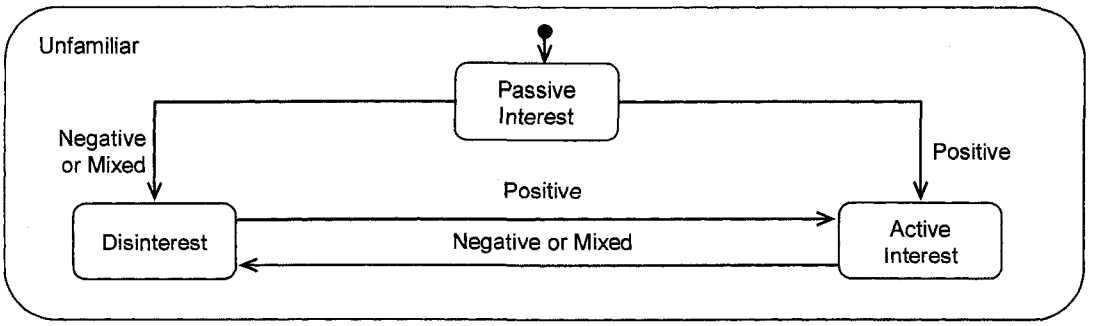


Figure 53. The Valence Axis in the Unfamiliar State

7.2.4.1. Passive Interest

Passive interest is a condition in which consumers attend to information which comes their way, but do not actively seek it out. At first, passive interest may consist of nothing more than a vague sense that a technology might be useful somehow:

> "I got a little e-mail on my Odin account about the Flexcar…I tend to keep my e-mails a long time anyway, just in case I want to look at them again. And I kept that one, just thinking 'Maybe I should see what this is all about.' I didn't click on the link for a long time. I just read it and thought 'Oh, I don't think that would work for me.' But I just kept it. I must have been thinking about it on some level, because I didn't delete it." [#1]

As consumers monitor information they begin to discover the capabilities and requirements of the option. Each such discovery creates a new temor; in this way, evaluation constructs knowledge about technologies.

7.2.4.2. Active Interest

During active interest consumers will proactively seek out information rather than passively waiting for it to come their way. It is hypothesized that a temor transitions to this state when a capability is discovered that relates to a sensitive motive. Informant #1 signed up for Flexcar about a month after she received an initial e-mail offer from PSU's Office of Parking and Transportation Services:

> "To tell you the truth, I didn't see where [Flexcar] would work for me, but I looked into it. I decided to get it because I thought, well you know, conceivably I could take the #12 from the Barbur transit center to downtown, get one of those Flexcars, and go see my mother in southeast Portland. Take her to lunch, take her grocery shopping, and get her back home and get back downtown in four hours. Because you have four hours, and then I wouldn't be using my gas. That's kind of what I thought, 'well, this might be a good thing because it will save me gas.' Even though it wouldn't save me time, because I'd have to drive or take the bus downtown. I thought, you know, the way the gas prices are this would be something good to have. And it might be something fun to do just to drive another car sometime, just for kicks." [#1]

7.2.4.3. Disinterest

Nothing is inevitable about adoption, and interest has a short shelf life. Disinterest is a state in which an option has been recognized as relevant to a need but has not generated enough excitement to motivate initial use. It may be that the need is not sensitive, or that current options are satisfactory, or that the need does not engage the emotions strongly enough to sustain interest. Disinterest is distinct from

irrelevance or rejection; irrelevance is a failure to recognize that an option is related to a need, and rejection only occurs after an option has been tried and judged unsatisfactory. Several informants became disinterested in Flexcar after they were unable to find a useful application for the service:

> "The four hour Flexcar limit really doesn't meet my present needs. When I drive to campus, I'm usually there less than four hours, so I just find a meter. I usually take the bus. Then I can get a nap and not have to hunt to park when I arrive." [#1]

Four months after signing up for Flexcar, Informant #1 gave up trying to find a use for it. Although she had registered as a member, she had never actually used the service.

7.2.5. Valence in the Familiar State

The decision to initiate first use occurs during the selecting process when an untried but promising option stacks up favorably in comparison to its rivals during an actual usage situation. First use can only occur if the new option's capabilities have positive valence to at least one sensitive motive, for otherwise it will never make the short list.

The valence axis (Figure 53) divides the familiar state into six substates: initial use, dominance structuring, positive evangelism, regret, negative evangelism, and differentiation.

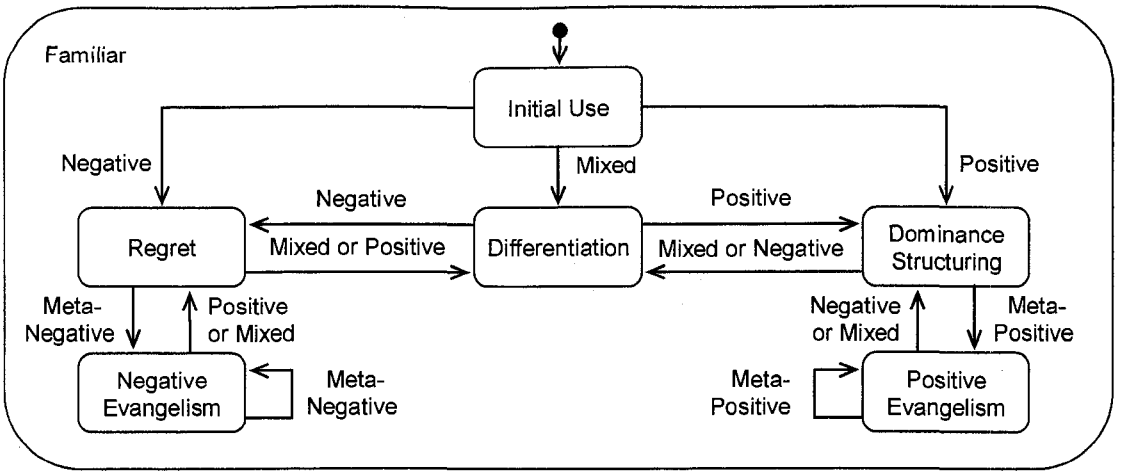


Figure 54. The Valence Axis in the Familiar State

7.2.5.1. Initial Use

By default, when a temor enters the familiar state it starts out in the initial use state. It is hypothesized that valence acquired prior to first use is only used to determine whether first use is warranted. After first use, consumers will tend to bracket or set aside prior valence and place greater weight on information which has been acquired first-hand. During initial use, 'the jury is out.'

7.2.5.2. Dominance Structuring

Dominance structuring is a condition in which a consumer attempts to construct a set of beliefs about the technology such that it dominates its rivals on every sensitive motive (Montgomery, 1983; Montgomery & Svenson, 1983; Svenson & Benthorn, 1990). Dominance structuring is familiarly known as "patting yourself on the back." Informant #10 decided to bike to campus for a year instead of buying the annual PP+ transit pass. After returning the pass for a refund he engaged in a bit of dominance structuring:

> "So I was like, 'Well, I've done due diligence. If I end up spending an extra hundred bucks that I would have saved, that hundred bucks is a cheap long-term mental psychological payment to know that I'm...I mean, it would be a beautiful thing if in September it turns out that I had lost a hundred bucks. Because then, for the next 20 years (if I work here for 20 years) I'm going to be solidly, completely grounded in the idea that riding the MAX is by far a fantastic decision to make. So I can't lose. If I saved money, I saved money. If I lost money, it's a cheap lesson to learn for the rest of the time I work here." [#10]

In the dominance structuring, regret, and evangelism substates temors undergo an unconscious 'consensus building' phenomenon known as the halo effect. Informant #14 formed a positive opinion of Flexcar and became an enthusiastic 'technovangelist'; observe how she plays down any negative aspects of the service:

> "I was a little scared. It's kind of like driving someone else's car. I'm so used to my own car, and I was a little...apprehensive. But once I got in it, and figured out the car, and did it, at the end it was 'That was great! That was great!! I'm gonna do this!' For one thing, the parking. There was always going to be a parking space, most of the time. [Laughs] And just being able to use it, and then put it back in the same place; having it right there, not having to worry about...if I have to, you know, get somewhere on the bus, which is sometimes what I would do, the availability of it...just the ease of using it. It's easy. And I think it's also that there's a lot of options; it's not just that car. I say, 'Oh, I can do that! I can go pick that up.' *And I go see that car is busy. Okay, well then I go to the Pizzacato car. Well, that one is busy. One time I had to go up to the gas station, that far, to get a car. But still, it was five blocks.* So I think 'ease', meaning lots of options. It's not just one car, one place, one time." [#14]

It is hypothesized that temors with positive or negative valence will try to induce other temors to revise their valence in the same direction (Janis & Mann, 1977; Montgomery & Svenson, 1983). The halo effect is discussed in more detail in Chapter 8.

7.2.5.3. Positive Evangelism

If the temors for an option can establish a consensus positive (or 'metapositive') valence, then *en masse* they will transition to the positive evangelism substate and the consumer will begin giving unsolicited testimonials to anyone within earshot. This is how Informant #14 became a Flexcar 'technovangelist':

> "Oh yeah, yes. I've been on my whole office about it! [Laughs] My first person who was [Informant #18]...she's now joined, and that's why I have the credit. Another person in our office takes the bus. And I haven't convinced her about the Flexcar yet, I'm not sure why. She just... 'I don't need it.' Yeah, or when I...just around campus, and somebody said 'Well, can you go here or there?' I say, 'I can get a Flexcar!' 'Oh!' So I talk to people about it, yeah. Because it really works for me." [#14]

Technovangelism goes well beyond ordinary word-of-mouth communication:

> "To hear his friends tell it, Matt Smith is an easygoing guy. A recently engaged business consultant from Charlotte, N.C., Mr. Smith, 31, is a casual fan of golf, Nascar, and Wake Forest basketball. But there is one subject his friends are loath to bring up around him, for fear it will provoke one of his prolonged sermons on its myriad virtues: the television gadget TiVo. 'I'd say he brings it up every time we're together,' said Fran Radano, a college pal who has resisted Mr. Smith's efforts to convert him to TiVo. 'There's usually someone in the group who's new to his preaching. It's highly annoying.' [...Mr. Smith] estimates he has talked 15 people into buying a TiVo – so far. 'If I'm at a cocktail party and I've had more than two drinks,' he said, 'I'm going to try to sell you a TiVo.'" (St. John, 2003)

It is hypothesized that persons receiving help or information events from a technovangelist are more likely to attribute these events to personal causes rather than technological causes. This accounts for why the events are given less weight: instead of being routed to temors for evaluating they are routed elsewhere.

7.2.5.4. Regret

A mirror set of states characterize the effect of negative valence. In the regret state people compare the quality of their decision outcomes to what they might have gotten if they'd made a difference choice (Loomes & Sugden, 1982; Dunning & Parpal, 1989). Regret is familiarly known as "buyer's remorse." Four months after purchasing Passport Plus, informant #5 felt he wasn't getting his money's worth:

> "Just around about Christmastime 2004 I called up the transit people at PSU, who administer the pass and asked them if I could turn it in and get a refund. And they said 'yes, and you go down to Neuberger, and turn it in, and you'll get a credit.' And when I went actually down to try and do that I was told I couldn't. [Laughs] Because the annual pass had actually been paid for to TriMet, and they couldn't get their money back, so I couldn't get my money back. So I kept the pass, but I probably used it maybe half a dozen times through the rest of the year." [#5]

Informant #10 was luckier. He purchased PP+ in October, two months into the annual service period. Since TriMet does not prorate PP+ passes, he still had to pay full price despite receiving only 10 months of service. After a few days he experienced buyer's remorse and returned the pass for a refund:

> "I took it back. I sat down and...there were a couple of factors. The factors were that I was behind by two months when the pass started. So basically I had to pay for two months just to catch me up. They don't prorate it." [#10]

7.2.5.5. Negative Evangelism

If the temors for an option can establish a consensus negative (or 'metanegative') valence, then *en masse* they will transition to the negative evangelism substate and the consumer will begin actively dissuading people from using the

technology. Informant #41 had a very upsetting encounter which soured her on riding the bus:

> "I rode the bus up to an interview at OHSU. There was this woman on it, and the bus driver asked her to stand up. She was in labor, and he didn't know, and she started to cry. And this other woman was like...old and...the bus driver was being mean to her, and she ran off the bus at OHSU. I felt sorry for her, and felt sorry for the whole system that people had to be mean to get by. I mean, I know that not every bus ride is like that, but it tainted the day for me. It just made me think I'd be better off riding my bike from now on. The bus in general is not something I want to take. I really wish there were another option. I don't know what that would be...The bus smells bad; it's expensive; I don't like to meet the people I see on it." [#41]

When interviewed again six months later, she was still volunteering negative opinions about the bus:

> "I do remember a statistic I read, which I find appalling: when you stand behind a bus, you inhale more toxic chemicals in one breath than a person in the Middle Ages inhaled in their entire lifetime. So, you know what? Screw buses! [Laughs] Honestly, I don't want them on the road with me. I know they're good for transportation for people who don't have cars, but they need to be all electric or something. That's how I feel about buses." [#41]

7.2.5.6. Differentiation

Differentiation occurs when a consumer splits a need into a more nuanced set of subneeds. This happens when a technology is discovered to be good for some things but not others. Over time informant #4 came to regard Flexcar as a mixed blessing:

> "Let's say I was going to use Flexcar to come here. 'Well, Brent, how long do you think we're going to be? Okay, it's Friday morning, I've got to give myself 45 minutes to get there and back, all right, let's say 3 hours...okay, I'll book it for 3 hours.' Well, we get over here and we go over, or they're doing construction on one of the routes I didn't know about when I'm driving over, and all of the sudden... So there's a lot of things, you either commit to that, or you overcommit and you lose out by spending more. Or, you go past your allowance for that day

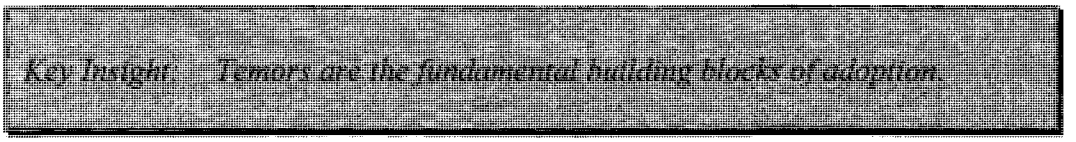
> with PSU and you pay for that. So, that's the challenge: you've gotta nail it on the head, 'cause if you underdo it and there's somebody after you, Flexcar calls them a cab and they get to have a chauffeured ride for their reservation! You pay for it! So, you know... [Nervous laugh]" [#4]

When a need differentiates, its temors will also split; the temor of the original parent need will take on mixed valence and transition to the differentiation substate, while its child temors will take on dichotomous positive or negative valence. The differentiating process is discussed in Chapter 8.

Consolidating is the reverse process: it collapses a set of needs into a single summative need. Political pollsters tap into this phenomenon when they ask respondents to sum up whether they think the country is "headed in the right direction." The consolidating process is discussed in Chapter 8.

7.2.6. Discussion and Summary

Evaluating is the process of judging how well a technology satisfies a motive; it is an operation of the temor class. Thus, adoption can be thought of as the process of constructing and using temors.



Evaluating is event-driven behavior that may be interrupted any number of times without disruption. It does not require the decision maker to maintain concentration or a continuous train of thought, and it typically unfolds over a longer

period of time than selecting. Between events the consumer's attitude with respect to the technology is "nearly" preserved, within certain limits.

Evaluating is characterized by three dichotomous axes, as shown in Figure 55:

Relevance: Is this technology relevant to this motive?

Familiarity: Have I ever before used this technology to satisfy this motive?

Valence: Is this technology of positive, negative, mixed, or unknown worth in terms of satisfying this motive?

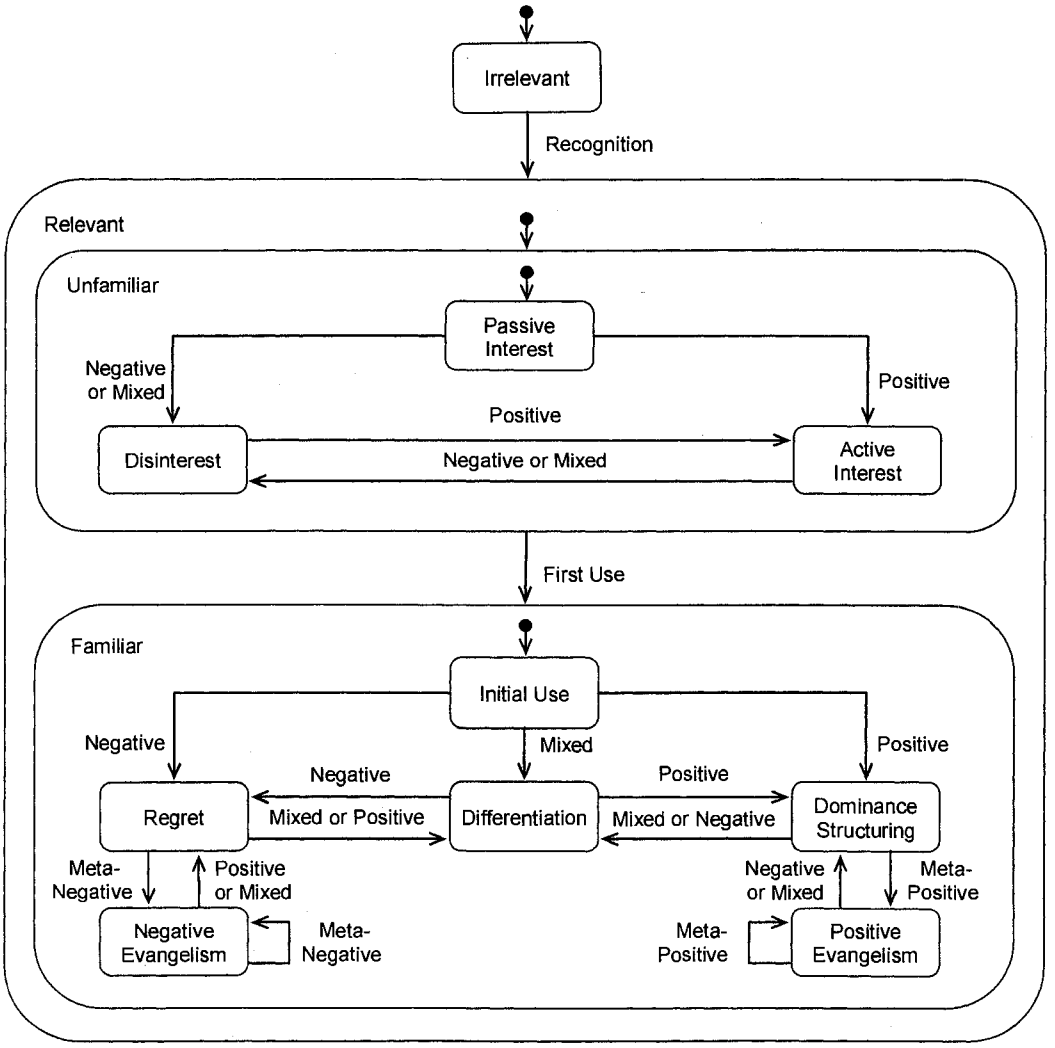


Figure 55. The Evaluating Process (Temor Class)

Selecting and evaluating are the yin and yang of adoption. Selecting chooses a technology to satisfy an immediate need; evaluating assesses a technology's capabilities and requirements independent of its rivals. Both may be understood as exercises in *ceteris paribus*: selecting holds the motives constant while varying the options, whereas evaluating holds the options constant while varying the motives.

Key Insight: Selecting and evaluating are cognitively distinct processes.

However, the independence of temors is not absolute. Through the unconscious halo effect they can influence each other to arrive at a summary judgment or 'metavalence'.

The split between the unfamiliar and familiar states has implications for survey-based adoption research. First use is driven by motives that are sensitive from the perspective of novice users, whereas discontinuance is driven by motives which are sensitive from the perspective of experienced users. Thus it is hypothesized that a factor analysis of novice and experienced respondents will reveal distinct populations which load on different factors.

7.3. Maintaining

Maintaining is the process of determining the functional status of a technology. It accounts for 57 of the 283 sequences (20%), and these are plotted in Figure 56.

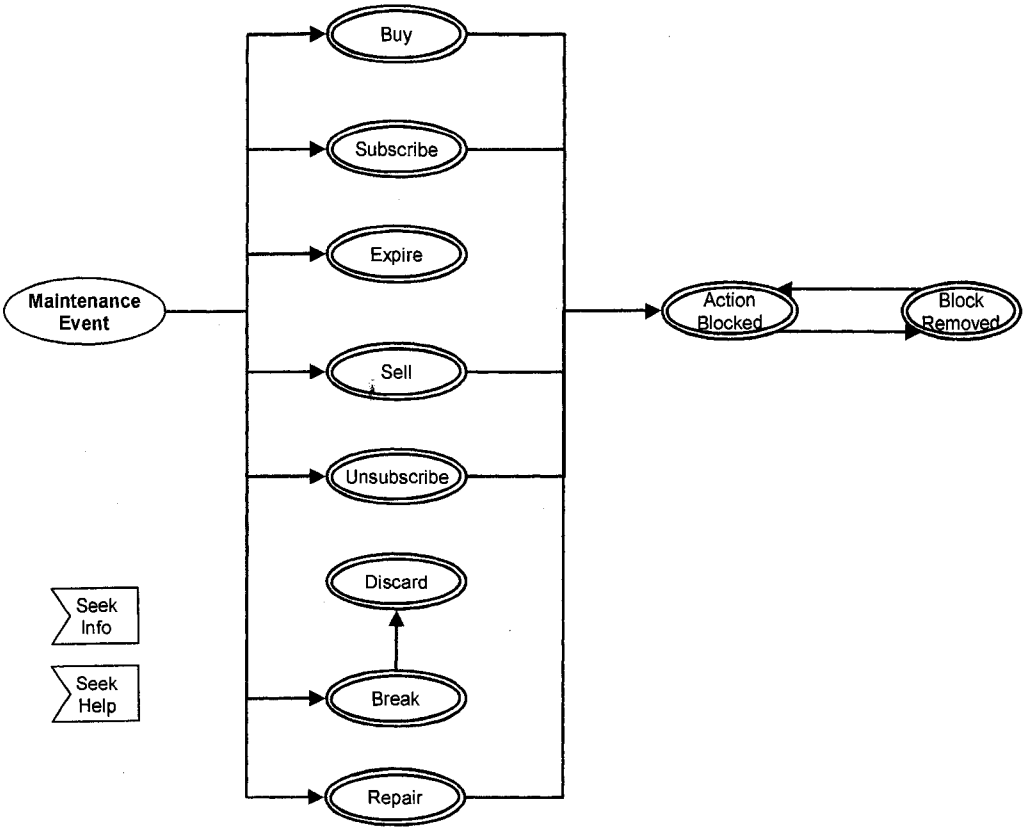


Figure 56. Sequence Plot for the Maintaining Process (n = 57)

Maintaining is an event-driven behavior of the technology class which is characterized by three dichotomous axes:

Obtainability: Can I get the technology?

Accessibility: Do I have the technology?

Operability: Does the technology function?

It is possible to satisfy one condition without satisfying the other. For example, my wine cellar may contain several bottles of a certain rare vintage which is no longer available: this vintage is *accessible* but *unobtainable*. I also have last year's vintage, which is *accessible* and *obtainable*. I could purchase another vintage from the wine shop down the street, but since I do not own any bottles of this vintage at present it is

inaccessible but *obtainable*. Obtainability acts as a guard condition on the transition from the inaccessible state to the accessible state. If I drink the last bottle of the rare vintage, it will become *inaccessible*; and because it is also *unobtainable*, I will be unable to regain access. The relationships between obtainability, accessibility, and operability are illustrated in Figure 57.

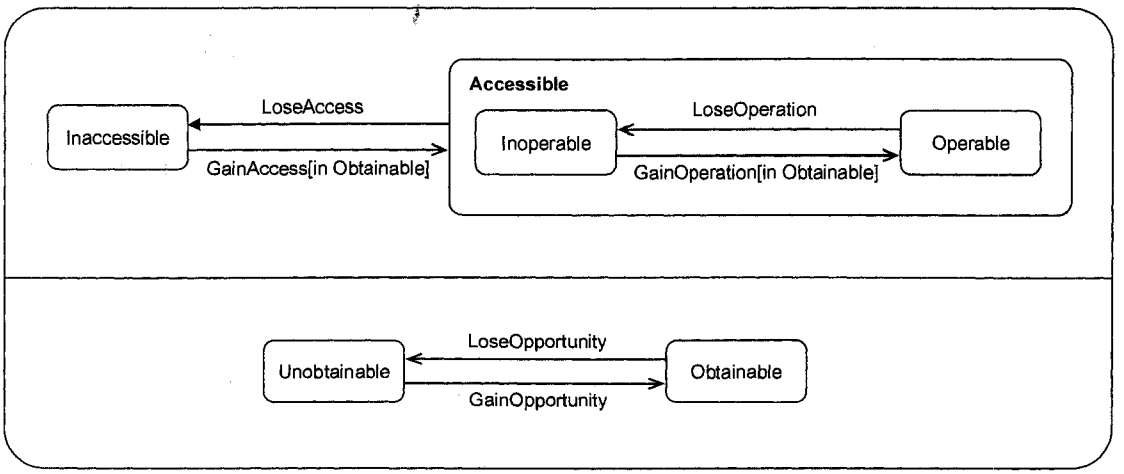


Figure 57. The Maintaining Process (Technology Class)

7.3.1. The Obtainability Axis

The obtainability axis measures whether there is an opportunity to obtain the technology, either now or in the future. Opportunity can be gained in many ways such as product offerings, service contracts, or exchanging social favors. It can be curtailed or eliminated via obsolescence, usage restrictions, and the like. I asked Informant #14, the Flexcar technovangelist, whether she used the service during the evenings or weekends:

> "I don't, because there aren't any in Gresham! I wish there were, because I have a $40 credit because I referred someone who joined. And the credit's sitting there." [#14]

Several informants living in the suburbs commented that they would use light rail to commute to the PSU campus except that the Gateway and Sunset transit center parking garages fill up too quickly on weekdays. Thus, parking is obtainable in principle but it requires 'good parking karma.' A technology is obtainable if the decision maker knows of *some* way to get it, even if that way is difficult and success is not guaranteed.

7.3.2. The Accessibility Axis

The accessibility axis measures whether a technology is at hand in the moment of need. As shown in Figure 57, it operates independently and in parallel with the obtainability axis. Access can be gained by purchasing a product, subscribing to a service, borrowing an item from a friend, etc. It can be lost by selling or discarding a product, canceling a service, allowing it to expire, returning a borrowed item, and so forth.

7.3.3. The Operability Axis

The operability axis measures whether a technology is functional. As shown in Figure 57, operability is only defined while the technology is in the accessible state. Operability can be lost if the technology breaks or its supplies are consumed; it can be gained by repairing the technology or replenishing its supplies.

Operability is related to accessibility and obtainability. I have an old typewriter in the back of my closet which is *accessible* in case I should ever need to use it.

Unfortunately, the ribbon has long since played out, so the typewriter is currently *inoperable*. A replacement ribbon is *unobtainable* for this model, so I am out of luck.

7.3.4. Discussion and Summary

Maintaining is the process of determining the functional status of a technology. It is an event-driven operation of the technology class which is characterized by three dichotomous axes: obtainability, accessibility, and operability. These axes bifurcate the state-space of the technology class as shown in Figure 57. Maintaining interacts with the evaluating and selecting processes by causing technological capabilities and requirements to come and go.

7.4. Chapter Summary

This chapter introduced selecting, evaluating, and maintaining. Selecting is the process of choosing a technology to satisfy an immediate need. Selecting is a simple behavior of the need class which is organized into framing, screening, and choice stages. Situational needs are determined in the framing stage; a short list of options is developed in the screening stage; and a finalist option is selected in the choice stage. If no options survive screening, the situation becomes sensitized. Since selecting only applies to immediate needs, it implicitly defines a seventh and final axis: *timing*, whether action is needed immediately or in the future.

Evaluating is the process of assessing how well a technology satisfies a motive. It is an event-driven behavior of the temor class which is characterized by three axes: relevance, familiarity, and valence.

Maintaining is the process of determining the functional status of a technology. It is an event-driven behavior of the technology class which is characterized by three axes: obtainability, accessibility, and operability.

Selecting and evaluating interact through sensitivity and beliefs. They also interact through help and information events, which interrupt selecting and give the evaluating process an opportunity to update beliefs. Maintaining interacts with selecting and evaluating through capabilities and requirements, which can come or go depending on the technology's current functional status.

CHAPTER 8. UNCONSCIOUS AUXILIARY PROCESSES

This chapter examines the unconscious processes that influence evaluating and selecting. These processes operate on motives and are all considered operations of the motive class. They are called 'auxiliaries' because they solve general problems that are not specific to adoption. They play a supporting role, but are nevertheless necessary for a full understanding of the adoption process.

Since informants are generally unaware of these processes, they are like 'black boxes' whose internal organization can only be inferred by observing their external effects. The present research design is not ideal for mapping their internal organization, so we will not attempt to describe these processes in detail; we will only characterize their external interfaces. A detailed analysis is beyond the scope of the present study.

The unconscious auxiliary processes are:

- *Perceiving*, which places an event in context;
- *Framing*, which recalls certain motives to memory;
- *Focusing*, which selectively directs attention to certain motives;
- *Categorizing*, which consolidates related motives into summary meta-motives and differentiates summary motives into finer-grained submotives; and
- *Acting*, which implement a plan.

8.1. Perceiving

Perceiving is the process of placing an event in context. Just because an event occurs while a technology is being used does not mean that the decision maker will attribute the cause of that event to the technology; it could be attributed to other factors such as human agency, other facets of the situation, or chance circumstances (Miller et al., 1973; Orvis et al., 1975). Attribution is context-dependent. Consider the case of three biking informants involved in car accidents, two of which occurred during the Winter Bikes cohort. Informant #26 attributed his accident to chance:

> "I understand that I'm just simply part of the percentage, and intellectually I understand that *I was just in the wrong place, wrong time*. Whatever, no hard feelings." [#26]

Informant #27 blamed himself:

> "I didn't have a headlight, so *I assumed it was my fault* because I didn't give him a way to be able to see me." [#27]

Informant #10 attributed the cause to biking itself:

> "Biking had become something that I stopped doing in Memphis because *it was just dangerous*." [#10]

Perceiving is a kind of routing function that forwards events to particular beliefs for evaluation. Perceiving is to evaluating what delivering the mail is to reading it; they are different processes performed by different actors, yet one always precedes and enables the other.

It is hypothesized that perceiving is a three-stage linear process, as shown in Figure 50 on page 149. During the first stage the decision maker constructs a situational context by determining which motives are involved; this utilizes framing,

an auxiliary process discussed in the following section. During the second stage the decision maker assesses whether the valence of the event is positive, negative, or mixed. During the third stage the decision maker attributes the cause of the event. If the cause is attributed to a technology, the event is routed to the appropriate temor(s) for evaluating; otherwise it is routed to a momor, passing beyond the scope of this thesis.

A number of experimental studies support this hypothesis. It is well established that valence is judged relative to context (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981; Kahneman & Miller, 1986) so situational context must be framed before valence is assessed. Furthermore, multiple studies have concluded that valence strongly influences causal attribution. For example, people tend to attribute positive behaviors to dispositional factors and negative behaviors to situational factors (Taylor & Koivumaki, 1976) especially in the context of racial prejudice (Regan, Straus, & Fazio, 1974; Pettigrew, 1979). People are also more likely to accept responsibility for successes than failures (Miller, 1976; Schlenker & Miller, 1977; Mullen & Riordan, 1988). Logically, valence must be assessed before cause is attributed. To summarize: we assess valence before we attribute cause, and we frame the situation before we assess valence – thus supporting the hypothesis that perceiving is a three-stage linear sequence.

8.2. Framing

Framing is the process of recalling certain motives to memory. It is a highly complex, context-sensitive process which has eluded efforts at a comprehensive theory (Beach & Mitchell, 1996). Only a general description will be attempted here.

8.2.1. Chains of Reasoning

Framing constructs chains of reasoning, networks of motives and technologies that are believed to cause particular outcomes or conclusions. Event A reminds us that to accomplish motive B we need technology C:

> "It just hadn't occurred to me that I should get a bus pass. [My niece] was getting one, and I'm helping her with her tuition. She asked me if I would buy her a bus pass, and that's what got me to thinking maybe I should get myself one." [#1]

When these chains conflict they must be reconciled. Informant #8 describes what it was like to juggle the transportation needs of her one-car suburban family:

> "Both kids are in elementary school, and I signed up to do the art literacy classes. Apparently there's no art anymore in school, so I signed up to do that. When I first signed up I thought, 'Well, I'll just do it in the morning, and I'll go to work a little late.' But they have a set curriculum in the morning; and my son was in afternoon kindergarten anyway. I typically can't take the bus to the school in the middle of the day, so that's when I started thinking about Flexcar a little bit. My husband just hated having to interrupt his day because he had to drive from Tigard to PSU and get me, then drive me to the elementary school in Tigard. I did the art literacy class, and then he drove me back to work." [#8]

Framing reveals fragments of the ontologies that we build and maintain throughout our lives. Most of this knowledge base is unconscious, unrevealed, and difficult to discover. However, over the years a number of projective techniques have

been developed for constructing 'mental maps' of consumer needs, feelings, and attitudes. One popular method is the Zaltman metaphor elicitation technique (Coulter & Zaltman, 1994; Zaltman & Coulter, 1995; Coulter, Zaltman, & Coulter, 2001) which was used to construct the mental map shown in Figure 58.

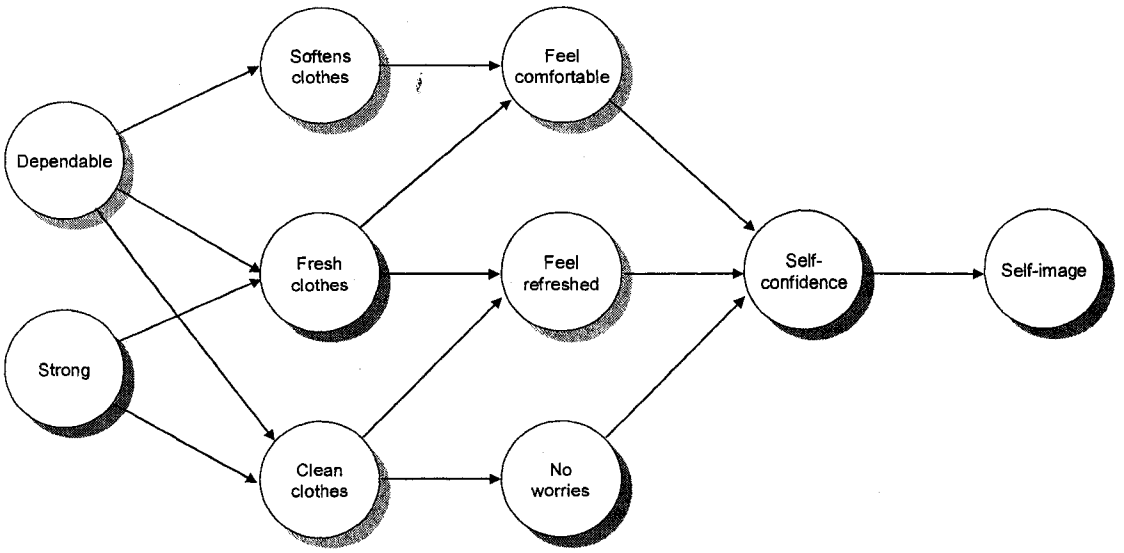


Figure 58. Partial Mental Map of a Detergent (Coulter and Zaltman, 1994)

For our purposes we are only interested in the structure of this mental map, not its content. All of the major structural elements from Chapter 6 are present in Figure 58: "dependable" and "strong" are images; "softens clothes", "clean clothes", and "fresh clothes" are technological capabilities; "feel comfortable", "feel refreshed", and "no worries" are situational requirements; and "self-confidence" is a need (verging on a desire) which stems from a deeper desire to maintain a positive self-image. The arrows represent the beliefs that bind the structure together.

We can glean from Figure 58 that the distinction between a need and a desire is somewhat arbitrary: is "self-confidence" a need or a desire? Fortunately, it is not

necessary to rigidly separate needs and desires, since desires are primarily useful as a conceptual device. As a practical matter, needs can function as if they were desires.

Figure 59 superimposes a chain of reasoning onto Figure 58: a set of conscious means (requirements and capabilities) which achieve a set of unconscious ends (images and desires.)

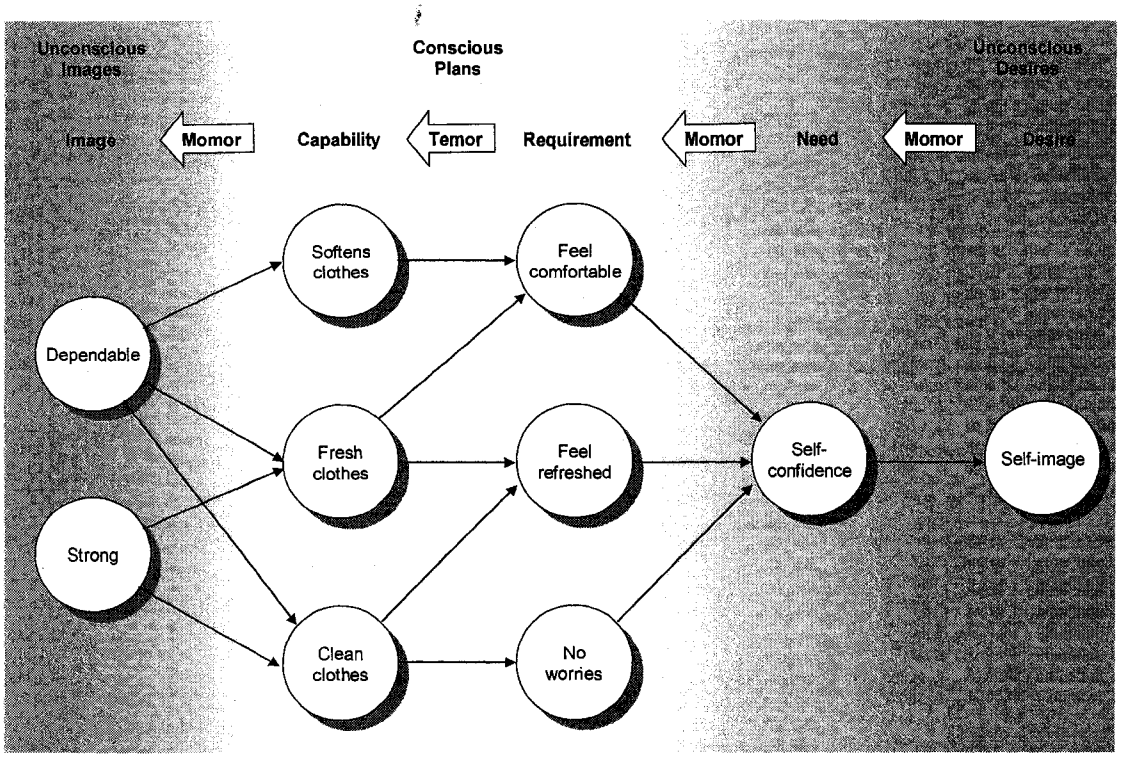


Figure 59. Informant's Chain of Reasoning for a Detergent

8.2.2. The Cycle of Means-Ends Reasoning

When David Hume famously proclaimed that "Reason is, and ought only to be, slave of the passions" (1739/1981, pg. 415) what he meant was that ends are emotional desires that are not subject to rational inquiry. For Hume, the role of rationality is to tell us how best to achieve our desires; rationality can only motivate

behavior when it is coupled with a value system – an image of something worth having. But how do we come to desire these particular images in the first place?

Clearly some kind of feedback is operating from images to desires, and from cognition to affect. We know from experimental research that goals are more attractive when they are feasible (Beach & Lipshitz, 1996) and that subjective probabilities and utilities are seldom independent (Slovic, 1966; Plous, 1993). This suggests that means-ends reasoning is actually a closed feedback loop, as shown in Figure 60.

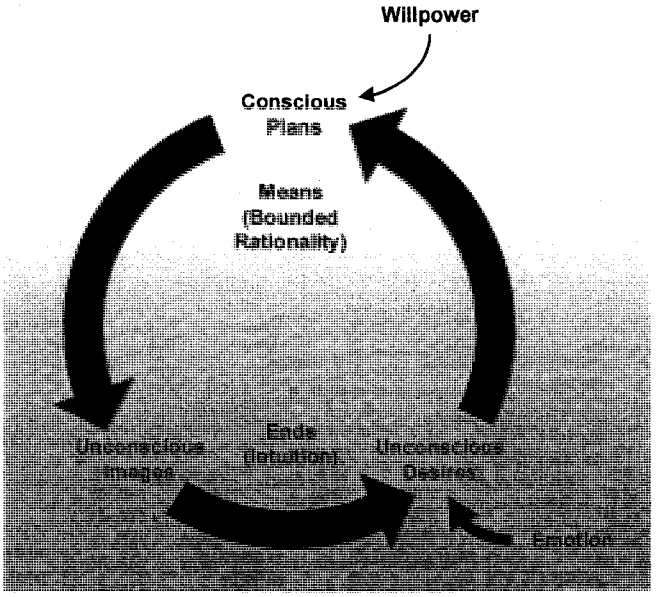


Figure 60. The Means-Ends Reasoning Cycle

We can see that the unconscious 'ends' are connected through intuition and the conscious means are arrived at through bounded rationality (Simon, 1956). Emotion is the primary driver, but it is balanced by willpower which enables us to choose among conflicting desires and gradually reshape the images that we desire.

Key Insight: Means-ends reasoning is a closed feedback loop.

8.2.3. The Self-Similarity of Motives

Needs are chains of reasoning motivated by desires. The need to do the laundry implies the need for detergent to wash our clothes, so that we can appear presentable, so that we can feel self-confident, so that we can maintain a positive self-image. Chains of reasoning have a recursive or self-similar organization: every need provides the capability to satisfy the requirements of one or more other motives, and each capability-requirement pair is governed by its own belief (momor.) Because motives are self-similar, they have fractal organizational structure – as do usage categories (bundles of related motives) and technologies (bundles of subtechnologies.)

Key insight. Usage categories and technologies have fractal structure.

Figure 61 expresses the recursive, self-similar structure of motives in UML form.

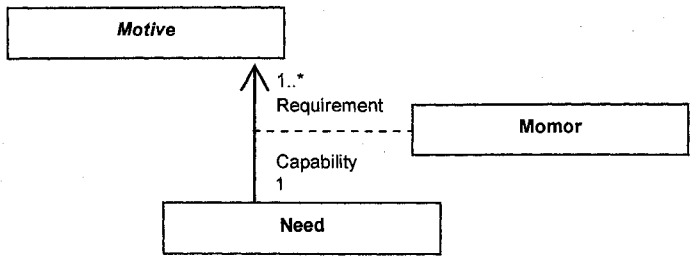


Figure 61. Recursive Motives

8.3. Focusing

Much of life consists of habit, and we pay only intermittent attention to our surroundings. Habit and sensitivity are obverse phenomena. Habituating is learning to ignore a stimulus by treating it as part of the background; sensitizing is learning which

stimuli to pay attention to. These phenomena enable us to focus our attention on the most salient stimuli in a situation while relegating all others to the background:

> "I do well when I have a habit. I could easily find an excuse to not ride [my bike], if I started to think about it. 'I want to wear this today,' or 'I don't feel like it,' 'I don't really feel that good,' 'I don't feel like I have very much energy,' 'It's going to be too cold.' There'll be some reason. Then, if I don't do it one time, it would be easier for me to say 'No, I'm not going to do it again.' So, I just wouldn't even visit the question; I would just get up and go." [#36]

> "Part of exercise or anything else you do is establishing a routine. I think it was laziness as to why I wasn't making that leap." [#12]

> "I have tried many different ways of dealing with the exercise conundrum. There's all kinds of ways to do it: you can go to a gym; you can run; I've done all of these things, at one point or another. What I've found is that if there's anything in my exercise program that involves going to a specific location, and changing and taking a shower in that location, I'm not going to do it. I'm just not going to do it. It feels like a piece of my day that's getting ripped away, and I really want to use my time for other things. It seemed to me that the bike is the easiest way to integrate that into my existence, because then it's just part of what I do to get to work and back. That, to me, makes a lot of sense." [#33]

Focusing is influenced by repetition, with positive stimuli encouraging habit and negative stimuli encouraging sensitivity. Of the two, we place greater weight on negative information (Kanouse & Hanson, 1972) because a 'shock to the system' is needed to jolt us out of the status quo.

The case study evidence suggests that any persistent, unsolved negative stimulus – no matter how unimportant it may seem at first – has the potential to decrease and even discontinue use in favor of a rival option. One of the Winter Bikes informants, #27, had a daily 30 mile round trip over the West Hills before he suspended bike commuting in late October. What bothered him was neither the

distance, nor the twice-daily trek over the steep hills, nor even the dangerously foggy weather conditions. He discontinued because his hands kept getting cold, despite every effort he made to keep them warm:

> "It was wearing me down, emotionally and physically. Riding every morning, just dreading your ride because it's going to be cold – no matter what gloves you've tried, or what different products you've tried to stay warm, even if they were waterproof, or whatnot. It was an emotional strain, a little bit. Just over the course of three or four weeks, I don't remember exactly, I just figured it wasn't worth putting myself through." [#27]

He desired to continue, and he also desired to stop; his emotions were in conflict. What kept him riding was willpower. For a while, his volitional desires were able to tip the scales between his competing hedonic desires. However, the persistent negative stimuli of cold, numb hands exacted a steady toll. He needed his hands for work, and the cold interfered with that. Eventually, his desire for comfort became so strong that his willpower could no longer compensate, and he put away his bike until spring.

Another informant became sensitive to the disruptive behavior of teenagers on the bus. At first he viewed these encounters as occasional annoyances, but as they persisted over the course of several months they became a real problem for him:

> "We caught the #75 northbound at E. Burnside. At the Glisan stop I knew the fun was just beginning, because there was a crowd of rowdy teenagers waiting for the bus, and two of them were having a fistfight over a basketball. They got on, and the two pugilists in question proceeded to sit right behind us, where they continued their verbal and physical sparring. When one of them fell against me, we moved to the front of the bus to get away from them – along with a couple of other adult passengers. The bus driver didn't do anything to stop this for several minutes, then just before we got off he made a halfhearted effort to suggest that they sit down and be quiet. Of course, they didn't.

> We got off at NE Tillamook and 39th, just as a large crowd of teenagers from Grant High School were boarding. Thank God we were getting off the bus, and not boarding it." [May 31, 2006 TriMet Journal]

The informant grew so tired of this rowdy behavior that he stopped riding the bus in the afternoons (around the time school let out) and instead began walking home from work every day – a distance of three miles. (He later took up bicycle commuting.) Again we see how an unsolved, persistent negative stimuli can sensitize a motive and eventually trigger discontinuance.

There is an operational link between sensitivity and selecting. If there are no surviving options on screening's short list, we can either quit or settle for less. Either way, we are likely to make a mental note that we should avoid similar uncomfortable situations in the future; this is how motives become sensitized. If the negative stimuli persist, they will further increase the sensitivity of the motive:

> "In general I'd say we've been less than delighted with these [biking rain gear] booties; they keep our feet dry to be sure, but the material is extremely inelastic and has no give whatsoever. The only shoes I have that fit my booties are my cheap sneakers. *Oh well...live and learn. I'll know better what to look for next time.*" [Nov. 22, 2006 Bicycle Journal]

> "It's actually why I ended up getting a car eventually, was because I eventually came to the point where I just had this deep desire to not feel like I was stuck without a way to get somewhere." [#10]

Sensitivity is important to quality of service. Flexcar is set up in such a way as to catch its users on the horns of a dilemma: when they reserve a Flexcar, they must estimate in advance how long they will need the vehicle. If through no fault of their own they are late in returning the car, they are liable to stiff fines and obligatory cab

fare for the (potentially angry) next person to reserve the car. If they try to avoid these fines by overbooking the vehicle, they or their employers must pay for any unused portion of the reservation. These policies make Flexcar inherently stressful to use:

> "There have been a couple of frantic phone calls on my cellphone, stuck on the interstate coming back to park [the Flexcar], like 'I'm late! I'm late! I don't know if there's anybody after me…can you extend the reservation? Can you do it?' It's always worked, but if you're on your own dime – or if you run out of time, because PSU limits you to 4 hours a day – you don't want to overbook so that you're paying more or go past your limit. But you don't want to underdo it so that you're frantic. It's that balance." [#4]

> "The stress of the Flexcar is every time. The lack of familiarity with the bus is a big first time stress, and then it tails off. The Flexcar is a lower stress, all of the time." [#3]

If these 'pet peeves' continue long enough, they can trigger diminished or discontinued use. But how long is 'long enough'? If it takes '30 days to make a habit', how long does it take to break one? The data hints that sensitivity behaves like some kind of moving average, but additional research is needed on this point.

What does seem clear is that sensitivity is caused by situations that lack a satisfactory solution. Furthermore, sensitivity is not the same as importance. Importance gets at compatibility with images – principles of right and wrong, visions of the ideal future, and life trajectories. The long-term focus of importance makes it more stable than sensitivity. Sensitivity is to importance what weather is to climate.

Key Insight: Adoption is driven by factors that are important to novices. Discontinuance is driven by factors that are sensitive to experienced users.

To illustrate this point, let us consider the experience of Informant #26, who was struck by a car and seriously injured during the course of the Winter Bikes case. This informant, a serious and experienced recreational biker, was proactive about safety issues due to having been struck by a car on a previous occasion:

> "It's going to be dark, I'll literally risk my life. But I've got lots of lights on my bike, I've got a great commuter bike, I've got great clothes...I've spent money. You can be seen, but it costs money." [#26, September 23rd 2006]

> "I bought a DiNotte rear light ($129) which is probably the best out there at 140 lumens. It is outstanding... brighter than most cars... but I still fear someone will not see me. Also, I have always thought that the importance of a headlight during urban commutes was more legal than anything. I can see just fine with the streetlights and such. But I'm going to invest in a much better front light to insure that I can be seen." [#26, November 7th 2006]

On December 7, 2006, in broad daylight and good weather, an elderly woman pulled out of a driveway directly into the path of Informant #26. She was leaving the eye clinic where her doctor had just cleared her to drive following cataract surgery. He struck her car broadside at approximately 25 MPH and flipped completely over her car. He was rushed to the hospital and was lucky to escape with his life. After the accident, safety loomed even larger as an issue:

> "I'm anxious to get back out, but I'm afraid, to be quite honest...I understand that I'm just simply part of the percentage, and intellectually I understand that I was just in the wrong place, wrong time. Whatever, no hard feelings. But it certainly changed my views and behavior about riding in limited visibility, and what is and is not an acceptable level of risk, as far as that goes. I'm sure that as time goes on that will fade, but right now it's kind of on my mind." [#26, February 17th 2007]

The accident served as a powerful negative stimulus, exposing the inadequacy of his precautions. Safety had been important to him before the accident, and afterwards it became sensitive as well. Over the next few months, as no new incidents occurred the sensitivity of his safety concerns gradually eased and he resumed his bike commute. However, he did not forget the incident, and safety remained as important as ever.

8.4. Categorizing

As we have seen, motives have self-similar organization: "doing the laundry" involves many plans, images, and desires that are bound together by beliefs. Usage categories are stable, socially constructed sets of motives; categorizing refers to the dynamics of these associations. The key categorizing processes are differentiating, consolidating, and the halo effect.

8.4.1. Usage Categories

Our tendency to pigeonhole options into conceptual categories is deeply ingrained. Just as some people regard a bicycle as a 'thing-for' getting around...

> "Even my friends would think it was idiotic to ride your bike in West Virginia...There was no encouragement and no bike community. Literally, nobody rode their bicycles. You just didn't. If you ever saw somebody riding their bicycle, you knew they lost their license for DUI and that was the only reason they were riding their bicycle!" [#23]

...others may regard it as a 'thing-for' economizing...

> "Cyclists [in Santiago, Chile] used to be seen as blue collar workers who'd drive their bikes to work to save bus fare. But today you see executives, government workers, lawyers, students – everyone is riding." [Public Radio International report, April 6, 2006]

...or a 'thing-for' losing weight and getting exercise...

"The bike, to me, is really a means to an end – bringing a better exercise regime into my life." [#36]

...or a 'thing-for' saving time...

"For me, I find it's far faster to cycle into work, especially with the showers at work. I live on the #14 Hawthorne [bus] route, and in the mornings, even coming every three to five minutes, that bus is packed. You're just squished in there, and they're making stops the whole way. It's probably about a 25 minute bus ride, which with the wait it ends up being a half an hour. I can get downtown on my bike in 15 minutes." [#4]

...or a 'thing-for' sport and recreation...

"Bicycling is like running or ice skating or skiing, it's a recreational thing." [#5]

...or a 'thing-for' expressing one's political beliefs...

"I regard my choice to ride a bike as political, for sure – to not use oil." [#31]

...or a 'thing-for' having fun.

"Bikes should be fun and comfortable. The whole idea of riding a bike is not to shave off time and ounces. It's to enjoy." [#22]

A usage category is a stable, socially-constructed set of motives. Categories help determine which motives are included as situational needs through a phenomenon known as associative priming (Plous, 1993). Categories and situations are linked: categories are archetypes of situations, and situations are specific instances (or "instantiations") of categories. For example, 'shopping' is a category which is comprised of several needs such as browsing, ordering, purchasing, tracking, and

trusting. But a trip to Trader Joe's this afternoon would be a situation – an instantiation of the shopping category.

Usage categories are deeply cultural:

> "A couple of months ago, in the privacy of his Reston townhouse, Alan Chien made a final break from cultural tradition, a guilt-filled decision he has yet to share with his parents. He used his dishwasher. He knows his parents will not understand. 'They don't believe in it,' said Chien, 35, an engineer who emigrated with his family from Taiwan when he was a toddler. 'Just because they never used it, I never used it, so it was just a mysterious thing to me.' In many immigrant homes, the automatic dishwasher is the last frontier. Long after new arrivals pick up football, learn the intricacies of the multiplex and the DMV and develop a taste for pizza, they resist the dishwasher. Some joke that not using the appliance is one of the truest signs of immigrant heritage, whether they hail from Africa, Latin America, Asia or Eastern Europe. If they have a dishwasher – and many do, because it is standard equipment in most homes – it becomes a glorified dish rack, a Tupperware storage cabinet or a snack-food bin. It's never turned on. [...] Chien has a hard time explaining dishwasher guilt...'I still have the sense that it's kind of a waste of electricity,' he said. 'It's odd. We buy American clothes; we use the oven; we use the stove; but, somehow that appliance...' [...] Kitchen historians speculate that the dishwasher lies at the heart of what it means to be a family. Dishwashers began appearing in many middle-class American households in the late 1960s and 1970s, about the time that many women began entering the workforce. A decade later, the microwave came along. The family dinner hour disappeared. It's been downhill from there." (Ly, 2005)

It is all too easy for us to presume that, if other people are using the same tools as we, they probably attach similar meanings to these tools – such as what it means to be a 'bike person'.

> "I thought if you're a bike person, then you had to wear toeclips. I was talking to this guy at work, and he's a bike fanatic. He was telling me about this movement that he counts himself among that's a reaction against the spandex-racer-lycra-toeclip-skinny-tire-racing-around-town, because it's not very appropriate. This is one of their things, they're kind of anti-toeclip-bike-nuts. It's not really an official group, it's just

> this movement of believers. They're into the aesthetic of older bikes, I'm not sure it's fixed gear, necessarily. They're not anti-technology, just appropriate technology I guess I would say. They seem to have this aesthetic of take the good from the old and combine it with the new, but do things that have a pleasant aesthetic to them." [#22]

A bike commuter and a weekend 'roadie' both ride bicycles, but that does not mean they construct similar needs or images around bicycles. As these quotes suggest, there is actually a certain degree of friction and resentment between these groups. The tendency to assume that other people form categories that are similar to our own has been called 'category error' (Ryle, 1949).

> "There's a lot of people I know as recreational riders who do things like Cycle Oregon, we do weekend rides, you know, we'll ride 50 or 80 or 100 miles on a weekend. But they would never ride two miles to the store to get their groceries. It's not on their radar. Bicycling is like running or ice skating or skiing, it's a recreational thing. And they just...it does not fit into their lives. Now, not everyone – I mean, there are a few people who are keen commuters, clearly. But there's a lot of people, it's just not on their radar. And they say 'Oh, it's far too dangerous.' I mean, they ride all the time for recreation, but they dismiss it entirely as a means of transportation. And I've had no success in convincing them that this is irrational [laughs] or getting them to change their minds." [#5]

8.4.2. Differentiating

As we gain experience at performing a new task – learning to bike commute, for instance – we discover that what we originally thought was a single need is in fact a collection of separate yet related needs:

> "Flexcar is a very good thing. But in a way, it only becomes helpful or desirable when it's a big deal, when the thing you're trying to do is a big deal. Like when you're going to Costco and you have to move lots of stuff; when you're trying to move your house; when you're trying to do those big things. Otherwise, for small stuff I just don't think it's useful." [#18]

> "I discovered a few things. One was that it wasn't actually much faster to ride to the Sunset Transit Center, put my bike on the train - sometimes waiting for the train 10, 15 minutes - and getting off at Goose Hollow, as opposed to just riding all the way. That wasn't a good tradeoff. Two of my students also lived out in the same direction, so in the evenings we often commuted home together, and that was actually a good time to connect with them. That was an opportunity I wanted to take advantage of. So, I found I was actually not using the transit pass more than a couple of times a month." [#5]

Differentiating is the process of disaggregating a summary need into a set of subordinate needs. Consider the experience of Informant #4:

> "My bike routes in town are sort of like fishing holes in a way. You get to know and trust certain routes. And I spend a fair bit of time playing with them. I've been doing more time riding Lloyd District riding from Hawthorne, and trying to find that right path. The other guys that ride that route, we sort of trade tips and ideas on what routes are probably the best. Dealing with Sandy and Burnside is sort of the big pain in the butt, figuring out where to cross Sandy and Burnside to get over." [#4]

Informant #4 has been riding his bike along NE 16th Avenue, a designated 'bike boulevard.' It makes a good route to work because it is a low traffic residential street – except when crossing East Burnside, which at NE 16th is a major 4-lane arterial with high-speed rush hour traffic and no signal for blocks in either direction. This dangerous cross street poses a negative stimulus every time #4 bikes to work, differentiating his original need to get to work and sensitizing him to safety issues (Figure 62.)

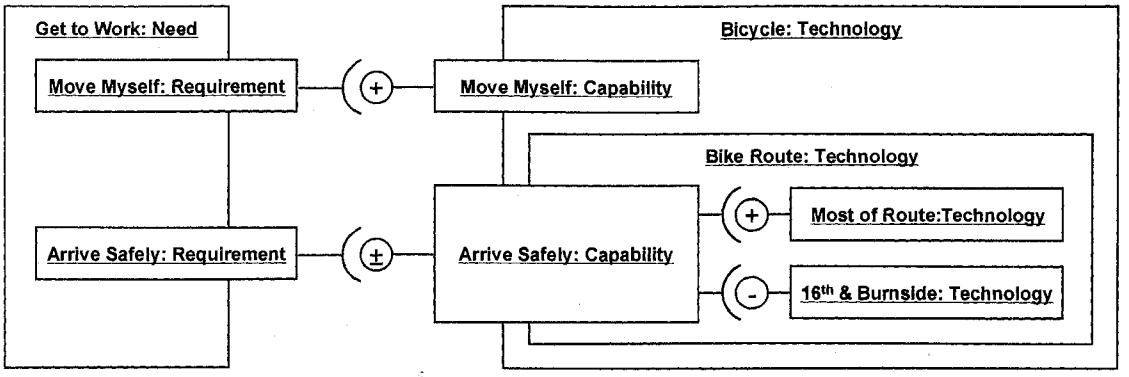


Figure 62. Differentiating Example

Could he solve the problem by finding a different route to work? Or by lobbying the city for a pedestrian/bike signal at this intersection? Or by altering his work hours to miss the rush hour traffic? If he can find a practical solution to his problem, he may continue biking to work, or he may ignore the problem and hope for the best. Alternatively, he may begin to question whether bike commuting is safe enough for him.

8.4.3. Consolidating

Consolidating is the mirror image of differentiating: it aggregates several related motives into a summary category.

> "We're certainly talking about consolidating our trips. We generally do that; we have done that. I do not like driving a mile to Gateway Fred Meyer just to buy one thing. My wife is very practical about getting up a list and planning trips, very good about that. As I said, she's a very organized person; she was a medical tech on the hill. So, when the car's ready to go out, usually there are several things to do, there are rounds to make on the weekends." [#6]

Consolidating is closely related to habituating, since categories often form around habitual behaviors. Consider the experience of Informant #1, an adjunct professor at PSU and PCC who acts as caregiver for her elderly mother:

> "There was a grocery store right across the street, so sometimes on my way home I would pick up some groceries too. That would also maximize the use of my car, because I could then get a bag of groceries, carry the heavy books and the groceries all home in one trip." [#1]

She needs to make the best use of her time, so on Tuesdays she has developed a regular routine. She first drives her car to the PSU campus and teaches a course, then shuttles over to the PCC campus and teaches a second class. Afterwards she swings by to check on her mother, then on her way home she visits the grocery store. She has repeated this sequence enough times that it has become her "Tuesday routine" (Figure 63.)

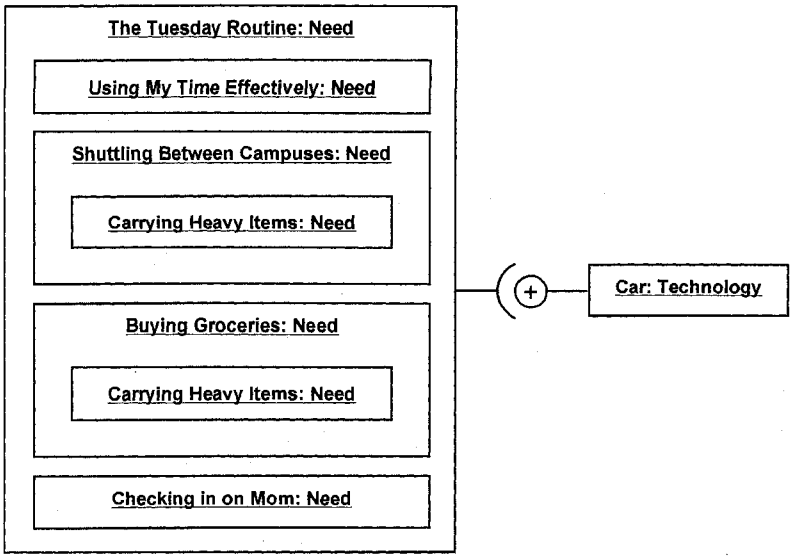


Figure 63. Consolidating Example

As far as her commute is concerned, Tuesdays are on autopilot until the current term ends. Consolidation has freed her mind to think about more important things. Habituating can be thought of as a strategy for conserving cognitive resources.

8.4.4. The Halo Effect

What triggers differentiating and consolidating? These processes are unconscious, so we cannot conclusively identify the causal mechanisms. However, the data suggests that differentiating and consolidating may be caused by the decision maker's ability or inability to maintain a consensus valence or 'metavalence' among a motive's beliefs. As long as the metavalence is homogeneous – either all-positive or all-negative – then there is no necessity for nuance, and the motive will remain undifferentiated. However, metavalence need not be unanimous. Differentiation will be triggered if the metavalence changes from unanimity to consensus (e.g. an anomalous negative belief is formed in the midst of uniformly positive set of beliefs.) Conversely, a summary need can be consolidated from a set of subneeds if their individual valences can be aligned to produce a consensus metavalence. The process by which beliefs influence each other's valence is called the halo effect (Thorndike, 1920; Asch, 1946).

We hypothesize that the halo effect is a weighted voting scheme in which sensitive and important beliefs are accorded proportionally greater weight. A new consensus metavalence emerges if the weighted sum passes a critical threshold (*a la* neural networks.) Beliefs that are at odds with the consensus metavalence undergo revision pressure in the direction of the consensus (e.g., if the consensus is metapositive, then negative beliefs will undergo pressure to become mixed, and mixed beliefs will undergo pressure to become positive.) These predicted revisions are summarized in Table 13.

TABLE 13. PREDICTED REVISION OF BELIEF VALENCE

	Consensus Metavalence	
Belief Valence	Metapositive	Metanegative
Positive	No change	Pressure to mixed
Mixed	Pressure to positive	Pressure to negative
Negative	Pressure to mixed	No change

Evidence in support of this hypothesis is provided by Montgomery and Svenson (1983), who studied attention to and evaluation of alternatives before and after a choice was made. Montgomery and Svenson found no significant changes in positive evaluations of the chosen alternatives and negative evaluations of the nonchosen alternatives, exactly as predicted by Table 13. Also as predicted, they found that negative evaluations of the chosen alternatives were positively revised after the decision, and that positive evaluations of the nonchosen alternatives were negatively revised after the decision. Figure 64 plots shifts in subject's evaluation scores between the first and second halves of Montgomery and Svenson's experimental protocol.

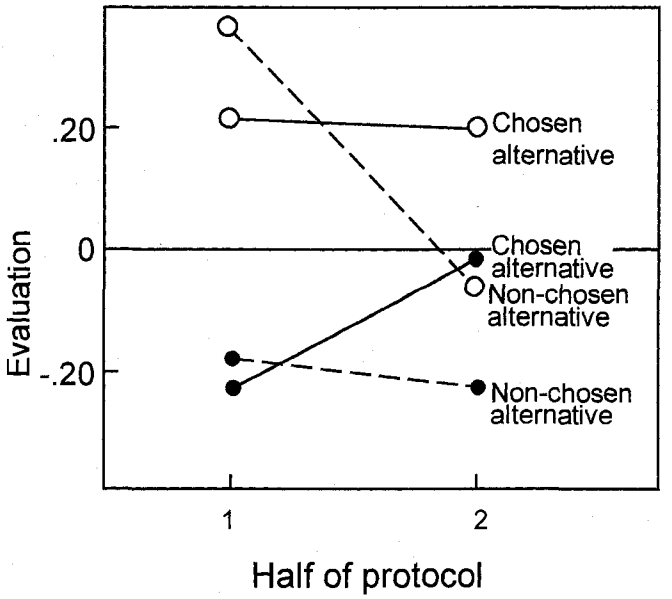


Figure 64. Revision of Evaluation from Montgomery and Svenson (1983)

As new beliefs are formed they will either conform to or conflict with the consensus metavalence. As long as the new beliefs conform to the consensus they will not trigger differentiating. If they conflict there are two possible outcomes. If the consensus is strong, the new belief will be 'outvoted' and the metavalence will be unchanged; the new belief will be treated as an exception or outlier and will undergo revision pressure as predicted by Table 13. If the consensus is weak, the new belief may tip the balance past a critical threshold and disrupt the old metavalence. If this happens, a period of chaos may ensue as the individual beliefs vie to construct a new consensus. (It is worth noting that new beliefs are likely to be sensitive and thus exert proportionally greater influence over the consensus than older beliefs.)

If the new consensus is the reverse of the older one then changes will be observed in the consumer's behavior at the macroscopic level. The extent of these changes will depend on the type of belief and the state of the consumer's belief system. If the beliefs are temors then the impact is likely to be rather limited; the consumer may simply shift from use to nonuse of a technology, or vice versa. But if the beliefs are momors such metavalence reversals are potentially more disruptive. The disruption could cascade up the chain of reasoning, tipping the consensus of higher-order metavalences. In the most extreme cases the disruption may spread to a person's images, resulting in an altered worldview with wide-ranging consequences (e.g., mid-life crisis, religious conversion, mental breakdown, even insanity.) The extent of the disruption will depend upon the state of that person's belief system at the time of the perturbation. The belief systems of most people will be quite robust even

in the face of strong shocks. Other people may have unstable belief systems that exhibit "self-organized criticality" and are prone to cascading disruption. More research is needed on this topic.

8.5. Acting

Most of what has been discussed so far has involved developing plans; we have not yet discussed acting, the process of implementing plans. Two opposing poles of acting are closure and procrastination.

Closure is an urge to finish acting: to 'get on with it', or 'turn the page', or 'cut to the chase.' Impatience, complacency, the reluctance to rehash a 'settled' issue, anger, fear, anxiety, panic, and other emotions loom large over decision making. In section 6.1.3 we discussed the case of Mr. Elliot, the brain-damaged patient who was stuck in analysis paralysis and could not cope with relatively simple decision tasks. When asked to schedule his next doctor's appointment, he would obsessively overanalyze the alternatives and constantly reframe the situation, taking irrelevant factors into account. Without his emotions to guide him, Mr. Elliot could not 'cut to the chase' or achieve closure (Damasio, 1994). Closure is an inherently emotional act that is dependent on a number of variables such as affect (Isen, 1997), personality type (Kruglanski, Webster, & Klem, 1993; Webster & Kruglanski, 1994; Kruglanski & Webster, 1996; Vermeir, van Kenhove, & Hendrickx, 2002), time pressure (Gigerenzer, 2000), sensitivity and habituating (Goodwin, 1977; Banister, 1978), and probably many more.

Procrastination is the opposing tendency: the urge to avoid acting. Four distinct varieties of procrastination emerged from the data. The first is denial, an unconscious strategy of avoiding action in unpleasant situations that lack easy solution (Janis & Mann, 1977). One way that denial can manifest itself is through an inordinate preoccupation with minor concerns. In War and Peace, Leo Tolstoy wrote of a regiment ordered to stand and wait while under shellfire during the battle of Borodino:

> "Without moving an inch or firing a shot the regiment lost another third of its men on the spot. Ahead of them, especially over to the right, the cannons boomed away through the never-thinning smoke...Most of the time the men followed their orders and just sat there on the ground. One man would take off his shako, loosen the gathers and tie them up again; another would crumble up some dry clay to clean his bayonet; another would adjust a buckle or tighten a strap on his shoulder-belt; someone else would re-roll his leg bandages with infinite care and pull his boots back on again. Some men built tiny houses out of clods of earth, or plaited together stubble straw. They all seemed thoroughly engrossed in what they were doing. When men got killed or wounded, when stretchers were dragged past, when our troops started coming back, when massed ranks of the enemy suddenly appeared through the smoke, all these developments were completely ignored...It was as if these morally exhausted men could find some relief in the ordinary events of everyday life." (Tolstoy, 1869/2006, pg. 898)

A second form is vacillation, an inability to reconcile tradeoffs. Informant #8 wrestled for months with whether the hassle of juggling her family's transportation needs was worth the cost of signing up for Flexcar, given her very tight budget:

> "I think in this case, the inconvenience that we've been experiencing, and the cost along, is enough to jolt me out of my slumbering state here in terms of, you know, I've been thinking 'Oh, it's not that big a deal.' But then last time...We're [driving the one car back and forth] again next Thursday and we did it on Monday. And I think 'yeah, it hasn't been too bad' but you know...I thought '$25 [the Flexcar signup fee] it's kind of hard sometimes to come up [with it]' I feel guilty, like we should be doing other things with that money. But in this case, I had already sort of set the summer as the last [self-imposed deadline]. We

> need to make a decision, I would probably be for it. But just the, you know, this year of...with costs going up, of gas, and making my husband drive back and forth two times. It seems kind of unfair not to say, we need to make a decision here. Certainly it's...I would say probably, I hate to say, more gas prices; and then the inconvenience issue. Also, we nearly got in an accident the other night, so you think, 'Oh! One more time out on the road with crazy people who don't know how to signal!'" [#8]

A third form of procrastination is foot dragging, a conscious strategy of delaying implementation of a clear but high-cost course of action in the hope that the problem will disappear of its own accord. Foot dragging is a conscious choice, which sets it apart from denial, and it differs from vacillation in that the course of action is clear – it is just difficult, unpleasant, or otherwise undesirable.

> "I might look into [Flexcar], but I don't feel it's high on my priority right now. I think it's nice to know it's out there. It's a nice idea...I know about it, I've seen it ...and the thought about it economically, probably makes sense. But I don't...as I said before, I'm a little lazy about it. I guess I have the sense, 'Well, that's a pretty good deal, I can look into it [later on if it becomes an issue.]'" [#6]

Finally, true procrastination occurs when a decision maker commits to a course of action which is seen as correct and necessary, but delays implementing that plan for lack of adequate motivation. True procrastination is not a deliberate strategy, which sets it apart from foot dragging. The decision maker acknowledges the *necessity* for action, what is lacking is the *motivation* for acting. Tasks can remain on the to-do list for days, weeks, months, or years:

> "You know, we also need to roto-till our yard, it's all rocks and weeds, pretty much. But actually going, figuring out what to do and doing it... once you get past that hump, then it's usually quite easy." [#8]

True procrastination seems to occur when there simply isn't enough emotional reward or pain involved to move away from the status quo. Since willpower relies on no justification or reason other than itself, it is entirely arbitrary and can be opposed on equally arbitrary grounds. On some level we sense this truth about ourselves, which is why we use little stratagems like "New Year's Resolutions" to trick ourselves into acting:

> "I feel like if I have the Passport it will be easier for me to roll out of bed and go "Ah, I'll just get on the bus today [instead of biking to work]. [#4]
>
> "And I thought, 'If I [buy the PP+ pass], that will encourage me not to want to drive." [#5]
>
> "The idea is that [not buying the annual PP+ pass] motivates me to get on my bike, and it *definitely* motivates me not to drive my car [because campus parking costs $8/day.]" [#10]

In the end, procrastination may be best understood as an urge to stick with the old status quo, whereas closure is an urge to hurry things along to a new status quo.

8.6. Chapter Summary

Five auxiliary processes operate on the motive class: perceiving, framing, focusing, categorizing, and acting.

Perceiving is the process of placing an event in context. It involves a three stage linear sequence of (1) constructing a situational context, (2) assessing the valence of the event, and (3) attributing its cause.

Framing is the process of recalling one or more motives to memory. Chains of reasoning are networks of motives and technologies which are believed to cause

certain outcomes or conclusions. These chains are part of closed feedback loops in which images and desires are connected through intuition and plans are arrived at through bounded rationality. Emotions drive the cycle, but willpower exerts an influence as well by reshaping the images of what we desire.

Focusing is the process of selectively directing attention to certain motives. It is influenced by repetition, with positive stimuli encouraging habituating and negative stimuli encouraging sensitizing. Any persistent, unsolved negative stimulus – no matter how unimportant it may seem at first – can trigger diminished or discontinued use.

Categorizing is the process of consolidating related motives into usage categories and differentiating summary motives into finer-grained submotives. Consolidating is related to habituating, and differentiating is related to sensitizing. The halo effect is an unconscious process whereby beliefs realign themselves with the consensus valence or 'metavalence' of the summary category.

Acting is the process of implementing a plan. Its opposing poles are closure, an urge to hurry things along to a new status quo, and procrastination, an urge to cling to the old status quo.

CHAPTER 9. VALIDITY AND GENERALIZABILITY

This chapter describes the steps taken to improve the validity and generalizability of the MTB framework. Since this is a qualitative theory-building study, evaluation criteria such as external and internal validity, hypothesis testing, and generalizability are defined somewhat differently than in quantitative research. In qualitative research validity is viewed as a direction rather than a destination; the goal is to increase confidence in the findings by addressing specific ways in which they might be wrong. This means that specific validity threats must be identified and ruled out *after* a tentative account has been developed (Maxwell, 1996). Evaluation standards for qualitative research are discussed in section R.11 of Appendix R.

9.1. External Validity

In the context of this study, external validity gets at the question of whether the theoretical framework and GAM accurately capture the relevant aspects of human behavior (Goldspink, 2002). This is an important question because the GAM is designed for use with agent-based artificial markets, where even relatively minor changes could result in significant differences in simulated market behavior (Epstein & Axtell, 1996, pg. 86; Durlauf, 1997). Table 14 lists several validity threats which were identified and addressed during the course of the research.

TABLE 14. EXTERNAL VALIDITY THREATS AND COUNTERMEASURES

External Validity Threat	Study Countermeasure
The cases might be unrepresentative.	Use Svenson's decision typology to select cases on a quasi-experimental basis.
The informants might be systematically biased.	Establish criteria to select informants for a range of innovativeness, adoption status, geographic dispersion, employer size, and greenness.
The decision settings might be artificial and unrealistic.	Collect context-rich data *in situ*.
The researcher might influence the informant's decision process.	Collect retrospective data on decisions which were made in the recent past.
The informants might selectively recall past decisions as being more structured than they actually were.	Collect longitudinal data on decisions which are currently in progress.
The researcher might arrive at invalid or premature conclusions.	Solicit feedback from informants on findings; actively seek out discrepant evidence and negative cases; collect multiple forms of evidence; employ multiple analysis methods.
A rival theory might provide a better explanation of the target phenomenon.	Compare the emerging theory to specific rivals: • Transtheoretical Model (Prochaska & DiClemente, 1984) • Concerns-Based Adoption Model (Hall, Loucks, Rutherford, & Newlove, 1975)

9.2. Internal Validity

For this study, internal validity refers to the correspondence between the MTB framework and the GAM (Goldspink, 2002). Mainstream social science has been slow to accept the methodological legitimacy of simulation research, in part from the perception that almost any desired result may be attained simply by tweaking assumptions hidden deep in the model (Waldrop, 1992, pg. 268). As noted by Andrews et al. (2005), theory-later agent modeling requires intense interaction between programmers and qualitative researchers as a grounded theory is formalized into an agent model. During this interaction conceptual ambiguities are forced into the open where they must be worked out in relation to the evidence. The present study improves the transparency of consumer agent modeling by making it possible to trace the parallel coevolution of the theoretical framework and GAM by means of a series

of modeling memos (see Appendix M.) Every change in the GAM corresponds to a change in the theoretical framework, and every change in the framework is linked to case evidence. Table 15 details the techniques used to strengthen the internal validity of the study.

TABLE 15. INTERNAL VALIDITY THREATS AND COUNTERMEASURES

Internal Validity Threat	Study Countermeasure
Data may be lost.	Keep the data and GAM under version control and run regular backups.
Traceability may be lost between data and theoretical framework.	Use the Atlas-ti software to facilitate qualitative analysis and maintain a chain of evidence linking the theoretical framework to the data.
Traceability may be lost between theoretical framework and GAM.	Use traceability matrix to maintain a chain of evidence linking the GAM to the theoretical framework.
Data analysis may be haphazard or unsystematic.	Maintain modeling memos to document changes to the GAM and questions arising during analysis. Follow systematic procedures for data collection, coding, memoing, modeling, and analysis. Use the GAM to help guide analysis, force conceptual clarity, and direct analysis in a systematic manner.

9.3. Hypothesis Testing

The main emphasis of this study was theory-building rather than theory-testing. A number of informal hypotheses were proposed during the course of the study (see Table 16.) Followup research is needed to test these propositions and assess the construct and predictive validity of the MTB framework.

TABLE 16. HYPOTHESES GENERATED BY THE STUDY

Hypothesis	Conclusion	Evidence
Selecting is a simple behavior.	Supported	Sequence data and prior literature (Beach and Mitchell, 1996; Potter and Beach, 1994).
All processes – regardless of domain – can be modelled as variations on simple behavior, event-driven behavior, or continuous behavior. (Osterweil's hypothesis)	Supported	Sequence data
Novice and experienced respondents are distinct populations that load on different factors.	Supported	Prior literature (Thompson, Hamilton and Rust, 2005)
Perceiving is a three-stage linear process consisting of (1) constructing a situational context, (2) assessing the valence of the event, and (3) attributing the cause of the event.	Supported	Prior literature (Kahneman & Tversky, 1979; Tversky & Kahneman, 1981; Kahneman & Miller, 1986; Taylor & Koivumaki, 1976; Regan, Straus, & Fazio, 1974; Pettigrew, 1979; Miller, 1976; Schlenker & Miller, 1977; Mullen & Riordan, 1988)
Temors with positive or negative valence induce other temors to revise their valence in the same direction.	Supported	Prior literature (Montgomery and Svenson, 1983)
The TTM will reveal a diverse range of informant adoption states.	Not Supported	TTM classification results
The process of evaluating a motive differs from the process of evaluating a technology.	Not tested	
A temor transitions to a state of active interest when a technological capability is discovered that relates to a sensitive requirement.	Not tested	
Valence acquired prior to first use is used to determine whether to proceed to first use. It is discounted if it conflicts with valence acquired after first use.	Not tested	
The halo effect acts as a weighted voting scheme in which sensitive and important beliefs are accorded proportionally greater weight.	Not tested	
Persons receiving help or information from technovangelists are more likely to be attribute these events to personal rather than technological causes.	Not tested	
The instability of the TTM and other pseudostage models is due in part to the failure to distinguish between a stage and a state.	Not tested	

9.4. Comparison to Rivals

This section compares the MTB framework with rival perspectives on adoption. The purpose in making this comparison is to look for insights that may have been overlooked in the analysis rather than to establish which framework is better. Classification-centered frameworks were chosen because of their potential to shed light on qualitative features of adoption and to identify potential pitfalls and blind spots. Two rival frameworks were selected:

- The Concerns-Based Adoption Model (CBAM, Hall et al., 1975), which classifies respondents on the basis of their acceptance of a favored option; and
- The Transtheoretical Model (TTM, Prochaska & DiClemente, 1984; Prochaska et al., 1992), which classifies respondents on the basis of their discontinuance of an non-favored option.

Several prominent adoption frameworks were excluded from comparison because their focus is on the prediction of variables that influence the rate of adoption rather than classification of qualitative adoption stages. Specifically excluded are CAVTs such as the Theory of Reasoned Action (Ajzen & Fishbein, 1980), the Theory of Planned Behavior (Ajzen, 1985), and the Technology Acceptance Model (Davis, 1989). During future research the MTB framework will be used as the basis for a structured equation model of adoption; at that time a comparison will be made to these rival CAVTs as part of quantitative hypothesis testing.

9.4.1. The Concerns-Based Adoption Model

The CBAM is a framework that defines adoption in terms of technology use. Primarily used in education to encourage the adoption of mandated programs, the CBAM is used to profile typical concerns which arise at various stages of the adoption process so that appropriate resources and interventions may be directed to potential adopters. The CBAM defines seven stages of adoption:

0	Nonuse
I	Orientation
II	Preparation
III	Mechanical use
IVa	Routine use
IVb	Refinement
V	Integration
VI	Renewal

CBAM classification was performed on all informants as part of the telephone prescreening interview. The purpose in making this classification was to ensure that the theoretical sample included informants with a range of current adoption status. The CBAM instruments are listed in Appendix B; classifications for the PP+ case are listed in Table 5 on page 93, and classifications for the WB case are listed in Table 8 on page 96.

Four of the 21 primary informants (19%) could not be staged by the CBAM algorithm:

- Informant #10 purchased the annual PP+ pass, but experienced buyer's remorse and returned it within a week for a refund.

- Informant #5 experienced buyer's remorse after purchasing PP+ but he waited too long before attempting to return it. He made sporadic use of PP+ until it expired, then did not renew the pass for the following year.
- Informant #4 used his PP+ pass less and less after he began riding his bicycle to campus. At the end of the year he allowed the pass to expire and did not renew it.
- Informant #18 was an early Flexcar adopter. The way she used Flexcar made it rather expensive, and after a period of extensive use she unsubscribed. A couple of years later she was hired by PSU. After an important person in her office subjected her to a certain amount of peer pressure she re-subscribed to the service. However, during this second subscription period she never actually used Flexcar, maintaining that she had 'mislaid' her membership card.

None of these informants could be classified by the CBAM for the simple reason that they had discontinued use. The CBAM invests technology with positive value and conceives of adoption as a progression leading up to full use. It is designed to help encourage adoption and makes no allowance for discontinuance; the CBAM assumes that adoption is the final outcome. It exhibits what Rogers calls pro-innovation bias, "the implication in diffusion research that an innovation should be diffused and adopted by all members of a social system, that it should be diffused more rapidly, and that the innovation should be neither re-invented nor rejected" (2003, pg. 106).

9.4.2. The Transtheoretical Model

The TTM is widely used to classify willingness to undertake healthier patterns of behavior such as smoking cessation, dietary changes, exercise adoption, condom use, drinking and driving, and the like. It defines four stages of adoption:

1. Precontemplation
2. Contemplation
3. Action
4. Maintenance

The TTM was administered to all informants prior to beginning the first interview. The purpose in making the classification was to collect data which could prove useful later, as hypotheses emerged from the MTB framework. Since it was not known in advance what these hypotheses would be, the TTM data were collected and reserved without computing their classification scores.[3]

After completing the bulk of the analysis for the PP+ case, it was hypothesized that the TTM scores would show broad dispersion, since the CBAM had been used to select informants who exhibited a range of adoption status (see memo M.69). This hypothesis was rejected after tabulating the TTM scores: far from revealing a broad range, all informants were classified in either the contemplation or action stages (see Table 17.)

[3] Classification scores were computed for the first two informants as a pilot test of the TTM instrument. On the basis of these scores it was determined that two of the questions (Q27 and Q28) were double-barrelled; the wording of these questions was changed for subsequent informants. These changes did not affect the classification scores for the two pilot informants.

TABLE 17. CLASSIFICATION RESULTS FOR THE TTM QUESTIONNAIRE

	Precontemplation	Contemplation	Action	Maintenance
Passport Plus	$n = 0$	$n = 5$	$n = 5$	$n = 0$
Winter Bikes	$n = 0$	$n = 6.5$ (1 tie)	$n = 4.5$ (1 tie)	$n = 0$
Total	$n = 0$	$n = 11.5$	$n = 9.5$	$n = 0$

As an additional test I took the survey myself. Since I have not owned a car in over five years I expected to be classified in the maintenance stage as a reflection of an established car-free lifestyle. Instead, I was surprised to be classified in the action stage, indicating that I was currently in the process of reducing car use. Clearly something was amiss here: either the questionnaire is flawed, the TTM is invalid as a classification model for transportation mode choice, or both.

The TTM was originally developed to measure smoking cessation, and it may be that the willingness to stop addictive behavior is not a good analogy to reducing automobile use. After all, cigarettes have no functional utility in the sense that cars do; furthermore, quitting smoking is an all-or-nothing proposition, whereas reducing car use is a continuum. These factors may partly account for the low discriminant validity of the TTM instrument. Other possible factors may be gleaned from the published TTM literature. Tucker (1999) was unable to stage a substantial proportion of respondents (210 of 1155, or 18.2%) and questions the adequacy of the underlying model and/or the staging measure. Rosen (2000) conducted a meta-analysis of 47 TTM studies and found inconsistent sequencing across health care domains: in smoking cessation, cognitive processes are used in earlier stages than behavioral processes; in exercise adoption and diet change, cognitive and behavioral processes increase together.

The difficulty of applying the TTM outside the domain of smoking cessation and applying the CBAM outside of the education domain suggest that the TADP is inherently domain-specific. For example, certain domain-specific regularities were observed in the evaluation profile for bicycle commuting (see memo M.9) as summarized in Table 18.

TABLE 18. EVALUATION PROFILES FOR BIKE COMMUTING

Evaluation State	Summer Bike Commuting	Winter Bike Commuting
1. Recognition	Dissatisfaction with alternatives; identification of role models	Dissatisfaction with alternatives; identification of role models
2. Passive interest	Early conversations with role models	Early conversations with role models
3. Active interest	Acquiring more specific information, help, and bicycle; making plans	Acquiring more specific information, help, and rain gear; making plans
4. Initial use	Setting a date and first trial ride to work	Experiencing first hard rain
5. Differentiation	Discovering and solving problems related to routes, bike equipment, and hygiene	Discovering and solving problems related to riding in cold, dark, and rain
6. Dominance structuring/regret	Habitual use, occasional use, or discontinuance	Habitual use, occasional use, or discontinuance

9.5. Generalizability

It is difficult to generalize the TTM and CBAM because they are bound up with historically-situated and context-specific input variables and outcomes. The MTB framework, by contrast, covers just a portion of the entire TADP. Referring to Figure 8 on page 27, the MTB framework is a CAPT that does not take inputs or outcomes into account. The discovery that technologies and usage categories exhibit fractal structure means that the MTB framework should be broadly applicable to settings beyond transportation mode adoption, since fractal structures arise from uniform generating processes. The mental processes described by the MTB framework are of universal scope.

From a computational standpoint, the MTB framework is completely general since motives, beliefs, and technologies are modeled as abstract classes of objects. However, before the GAM can be made operational it must be linked to context-specific inputs and outcomes as shown in Figure 8 on page 27. A common software engineering technique could be used to achieve this linkage. In commercial software it is common to develop general-purpose systems that are customizable to context-specific applications. For example, a company that makes voice mail systems cannot anticipate all of the ways that its customers may wish to use these systems (e.g., a law firm needs a different voice mail menu than a credit card company.) Since it is impractical to hard-code every conceivable variation into the software, voice mail systems are designed to use a script-based architecture: a simple interpretive language is used to give customers the ability to customize their own voice mail menu by constructing simple sentences of verbs (processes) that perform operations on nouns (objects). Something similar is envisioned for the GAM. The GAM will be implemented as a simple language of nouns (e.g. motives, technologies, capabilities, and requirements) and verbs (evaluating, selecting, maintaining.) Anyone wishing to model a specific adoption process (e.g., smoking cessation) will construct a script for that process from these basic building blocks. From a computational standpoint, then, the GAM is flexible enough to describe virtually *any* adoption process. A script language interface would make the GAM compatible with popular agent architectures such as the Belief-Desire-Intention framework (Bratman, Israel, & Pollack, 1988).

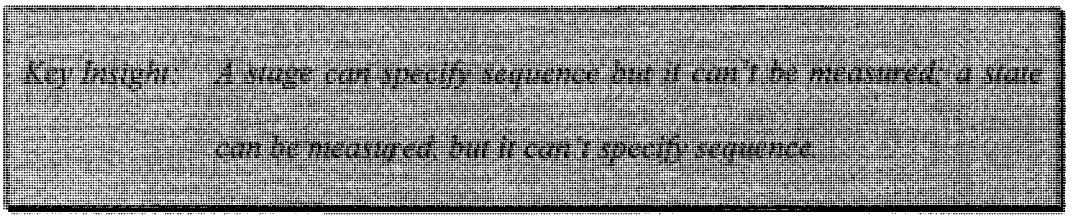
This study's findings are only partly generalizable with respect to decision type, since theoretical content was sampled from decisions involving conscious resolution of tradeoffs (Svenson's Type III) as well as decisions involving the construction of alternatives (Type IV). It is unclear whether the MTB framework is applicable to unconscious decisions (Type I) or quick conscious decisions (Type II) since these were not sampled. The largely automatic nature of Type I/II decisions poses an epistemological threat to the elicitation-based methods that were used to develop the MTB framework. With a suitable choice of parameters, it is possible that the MTB framework could be applied to Type I/II decisions, but more study is needed.

Since the study relied on theoretical rather than statistical sampling, its findings are not generalizable with respect to populations and cannot be used to draw inferences about factors that influence adoption rates or outcomes. This limitation is part of the price for having a completely generic CAPT.

9.5.1. Discussion

Progression through the evaluation states was marked by certain regularities such as identification of role models and the need to purchase equipment. It is all too easy to jump to the conclusion that these regularities are evidence of *stages* rather than *states*. The distinction is subtle but important. Stages are information processing structures that flow from one task to the next in a certain necessary sequence (not necessarily a linear sequence.) They are inherently unstable for measurement purposes because they are not defined in terms of characteristic conditions or variables. But as we concluded in Chapter 7, evaluation is characterized by states rather than stages.

States are control structures that are defined in terms of a prevailing set of conditions. They are not information processing structures and they imply nothing about sequence. This paradox is analogous to the Heisenberg Uncertainty Principle:



Weinstein, Rothman and Sutton (1998) allude to this paradox in their review of staged theories of health behavior. They distinguish between continuum theories (e.g., the Theory of Reasoned Action, the Theory of Planned Behavior, and the Technology Acceptance Model) and staged theories, which are distinguished between true staged theories (e.g., the Precaution Adoption Process Model) and 'pseudostage' theories (e.g., the TTM.) Weinstein and colleagues argue that four criteria distinguish a staged theory from a pseudostage theory: 1) a classification system to define the stages; 2) an ordering of the stages; 3) people in the same stage face common barriers; and 4) people in different stages face different barriers. Because the TTM does not meet these criteria, Weinstein and colleagues consider it to be a pseudostage model – a framework that superimposes stages onto a continuum.

In the context of the present discussion, the second of Weinstein's criteria clearly refers to stages (process flow), whereas the others refer to states (process control.) It is hypothesized that one reason for the instability of the TTM and other pseudostage models is because they do not adequately distinguish between a stage and a state.

CHAPTER 10. CONCLUSIONS

10.1. Overview

Despite an abundance of adoption studies, CAPT has been stagnant for decades and seldom subjected to much critical examination or scrutiny. In consequence, the DOI literature is unstable – different studies identify different factors as important. Without CAPT, DOI lacks a theoretical basis for resolving inconsistencies across studies and guiding the refinement of CAVT. A second problem is that DOI does not lend itself to controlled experimentation; for the past 40 years diffusion forecasting has been dominated by aggregate approaches like the Bass model that grossly simplify diffusion behavior and limit the value of DOI research to practitioners.

Agent-based artificial market simulations show great promise to break this impasse and usher in a new era in DOI research. Simulated consumer agents could help identify new markets before they emerge and model aspects of diffusion dynamics that are currently beyond reach. However, their development is hampered by a shortage of CAPT that could help guide their construction.

Thus, both management problems – the instability of DOI research and the inability to conduct controlled DOI experiments – can be traced to a common root cause, the lack of CAPT. This research makes several important contributions toward closing this gap in the literature.

10.2. Theoretical Contributions

In reviewing the theoretical contributions of this study, it is helpful to revisit Steinfeld and Fulk's (1990) discussion from Chapter 1 on the uses of theory:

- To provide a framework for identifying empirical patterns;
- To resolve inconsistencies across studies;
- To generate hypotheses by which generalizable conclusions may be tested;
- To provide perspective on larger issues;
- To recommend directions for future research; and
- To help integrate knowledge from related fields.

The MTB framework has advanced the state of knowledge in every respect.

10.2.1. Provide a Framework for Identifying Empirical Patterns

The MTB framework conceives of adoption as a psychological and social process by which beliefs about a tool change over time in response to certain events. Three mental structures are involved in adoption: motives (inner mental reasons), technologies (tools that pertain to motives) and beliefs (associations between motives and/or technologies.)

Three conscious processes govern the behavior of these structures. "Selecting" chooses a tool to satisfy an immediate need; it requires a certain degree of cognitive flow or concentration. If selecting is interrupted, it must be restarted – although subsequent passes need only recapitulate the process in a gross sense. "Evaluating" constructs beliefs about a tool; it is event-driven and unfolds over a longer time

horizon than selecting. Evaluating is the primary mechanism by which beliefs are created and changed, although beliefs can also change through the unconscious halo effect. "Maintaining" determines the functional status of a tool; it is also episodic and is driven by empirical facts. Five unconscious auxiliary processes – "perceiving," "framing," "focusing," categorizing," and "acting" – govern motivation.

Capabilities and requirements are the pegs and sockets that connect the structural elements. They are discovered during the evaluating process, when they are combined with valence to construct new beliefs. During the selecting process these beliefs are used to screen the technology options and choose a plan of action. Capabilities and requirements can come or go depending on the current maintenance state of a technology.

This study has made several unexpected discoveries about adoption. The first is that *the atomic unit of adoption is the temor*, a belief that associates a technology with a particular motive. On the most fundamental level, adoption is the process of constructing and using temors. Beliefs that associate two motives are called momors; it is hypothesized that momors are to learning what temors are to adoption. Temors express 'how' beliefs, whereas momors get at 'why' beliefs.

Another non-intuitive insight is that *adoption is driven by factors that are important to novices, whereas discontinuance is driven by factors that are sensitive to experienced users*. First-hand use bifurcates technology users into two populations – novice and experienced – because experience changes beliefs more deeply and richly than hearsay.

Sensitivity is distinct from importance: the former derives from short-term plans, whereas the latter derives from long-term images. Sensitivity is also different from habit: sensitivity is learning which stimuli to pay attention to, whereas habit ignores stimuli by treating them as part of the background. Sensitivity may be understood as a strategy for conserving focus. It looms large over the adoption process because people tend to give greater weight to negative stimuli over positive ones, short-term rewards and disincentives over long-term ones, and repeated incidents over isolated occurrences. Users can become so sensitized to a recurring pattern of unmet needs that they may reduce or discontinue their use of a technology in favor of its rival. By lowering the psychological barriers to entry by rival technologies, *sensitivity is an important mechanism driving technological substitution.*

The study also revealed that *selecting and evaluating are complementary* ceteris paribus *processes that operate in tandem.* Selecting holds the motive constant and varies the technologies; evaluating holds the technology constant and varies the motives.

Finally, it was found that *motives and technologies exhibit fractal structure* in the sense that they may be consolidated or differentiated into units that are recursively self-similar. The composition operator for technologies is "bundling"; a technology may be unbundled into a set of subtechnologies as long as at least one of them can provide a capability of its own. Technologies that cannot be unbundled are called primitives. The composition operator for motives is "consolidating" and the decomposition operator is "differentiating"; desires are primitive motives that cannot

be further refined. Inconsistencies or conflicts that inhibit the consolidating process are resolved through the unconscious halo effect.

10.2.2. Resolve Inconsistencies Across Studies

The study helps solve the instability problem by identifying seven dichotomous adoption criteria:

Timing	Is there an immediate need?
Relevance	Is this particular technology relevant to the need?
Familiarity	Have I used this technology before?
Valence	Is this technology effective, ineffective, mixed, or unknown in terms of meeting the need?
Opportunity	Can I get this technology?
Accessibility	Do I already have this technology?
Operability	Is this technology functional?

These criteria will be validated as part of a long-term research program to assess the construct, discriminant, and predictive validity of the MTB framework in relation to its rivals and increase confidence in the GAM. During the first study the criteria will be used to develop a questionnaire to classify a respondent's adoption status with respect to the GAM. A cross-sectional comparison will then be made to identify 1) commonalities among people in the same states and 2) differences among people in different states. Subsequent studies will sample larger populations to validate the transition sequences of the GAM and identify factors that are predictive of

state transitions. Later in the program the predictive power of the MTB framework will be assessed with respect to rival theories by conducting experimental studies of matched and unmatched interventions. By developing a better instrument to measure adoption the MTB framework will help to alleviate the instability of DOI research.

10.2.3. Generate Hypotheses by Which Generalizable Conclusions May be Tested

Although the primary aim of this study was theory-building rather than hypothesis testing, the MTB framework is sufficiently precise to generate testable hypotheses (see Table 16 on Page 201.) The GAM has already been used to generate theoretical propositions in relation to the data, and an explanatory mechanism for the halo effect was able to account for experimental observations by Montgomery and Svenson (1983). An important future test is whether (with a suitable choice of parameters) the selecting, evaluating, and maintaining processes will be able to accurately describe the behavior of Svenson Type I and II decisions. Confirmation of this hypothesis would be of considerable interest, since it would elevate these processes to the status of universal microlaws.

No research is perfect, and this study entails several limitations. The MTB framework is a work in progress, and certain aspects are known to be in need of further conceptual development. In particular, it is felt that the dominance structuring and regret states of the evaluating process are not quite right yet. These states have a 'stagelike' character that is defined in terms of information processing rather than status; the entry and exit criteria of these stages are not clearly enough defined. All of

the transition relations of the evaluating process need to be tested by confirmatory factor analysis. More research is needed to refine the framework.

10.2.4. Provide Perspective on Larger Issues and Knowledge Claims

Three findings have implications beyond the immediate objectives of the study. The first pertains to the role of intuition in decision making; the second extends Heisenberg's uncertainty principle to process philosophy; and the third provides evidence in support of Osterweil's hypothesis.

10.2.4.1. Bounded Rationality and Intuition

According to the standard or 'Humean' theory of motivation, the primary drivers of human behavior are the emotions. Willpower can arbitrate among conflicting emotions, but it cannot directly oppose them; the will's role is to work out the best means of achieving desires, not to formulate them. While we generally concur with Hume's conclusions, this study found that *means-ends reasoning is a closed feedback loop* rather than a linear chain. 'Ends' suggest a linear metaphor, and linear thinking is a common pitfall in human reasoning (Sterman, 2000). As shown in Figure 60 on Page 176, the cycle of means-ends reasoning begins when a person desires to bring about a more ideal state of affairs. Using bounded rationality, willpower then formulates a set of plans for achieving these desires. If the attainment of these desires reinforces that person's images of an ideal future, then new desires will arise through unconscious intuition and the cycle will repeat.

Success images can cause people to desire ever increasing amounts of goods, money, power, fame, etc. In a sense, successful retailers like Ikea, Starbucks, Abercrombie and Fitch, Crate and Barrel, and so forth are not selling goods or services so much as they are selling images and experiences of an idealized lifestyle. They advertise images of an ideal future as well as the inferred means of attaining those images.

Of course, attaining one's desires is no guarantee that these images will come to pass. These images may conflict with other components of self-image such as principles of right and wrong (e.g., 'greenness'; maintaining a healthy diet and lifestyle; spirituality; the virtue of leading a simple life, etc.) When images conflict they will give rise to discordant, competing sets of desires that the will must arbitrate.

Thus, *Simon's concept of bounded rationality is correct, but incomplete in that it undervalues the role of unconscious images and intuition in decision making.* The will is important in two ways: in the short term, to arbitrate between conflicting emotions; and in the long term, to influence and reshape the images of what we desire.

10.2.4.2. The Uncertainty Principle and Process Philosophy

In Chapter 2 it was noted that staged adoption models share several systematic weaknesses such as overlapping stages, difficulty in clearly distinguishing between stages, skipped and out-of-order stages, truncated search procedures, and weak empirical support. Given that adoption has been the main dependent variable for a considerable number of studies, the inability to clearly measure the stage of adoption must be reckoned as a serious problem in DOI research.

In Chapter 9 we traced the cause of these measurement problems to confusion regarding the difference between a stage and a state. A stage is an information processing structure that can describe the sequence of a process, but cannot be accurately measured. A state is a control structure that can be accurately measured (e.g. by defining entry and exit criteria), but cannot be used to specify sequence. The error made by staged models like the CBAM and the TTM is in attempting to use the same structure to both specify sequence and measure progress. Accurate measurement of adoption – or any other process, for that matter – requires a combination of stages and states.

Heisenberg's uncertainty principle states that it is impossible to precisely specify both the position and the momentum of a particle at the same time. The degree of uncertainty can never be reduced below a certain theoretical limit. The uncertainty principle was a major advance in physics and made a deep statement about the structure of the universe: there is a fundamental limit to how accurately certain pairs of variables can be measured simultaneously. Quite unexpectedly, this study finds that *the uncertainty principle – or something analogous to it – may also be inherent to the relationship between information flow and control.*

10.2.4.3. Osterweil's Hypothesis and Process Philosophy

Osterweil's hypothesis states that process *is* software, regardless of domain. This study provides evidence in support of this hypothesis by demonstrating that software principles also hold for psychological and social processes. This is not simply a matter of using software to model mental processes; *this study has used fundamental*

software engineering principles like simple and event-driven behavior to make non-obvious yet successful predictions about psychological and social phenomena. Prior to this study there was little basis for supposing that software principles would be applicable to psychological phenomena. By providing empirical evidence in support of Osterweil's hypothesis, this study contributes to Whitehead's process philosophy and makes a metaphysical statement about the relationship of software principles to all kinds of process.

10.2.5. Recommend Directions for Future Research

As discussed in Chapter 3, artificial market simulations of calibrated consumer agents could be used to forecast future market behavior, explore market dynamics, facilitate management education and training, develop new public policies, analyze massive market databases, game organizational strategies in volatile new markets, and mine profiles of new products and services which do not yet exist, but which markets are poised and ready to accept. We believe that agent-based artificial markets are destined to play an important role in the future study of innovation dynamics.

An innovation is literally a "thing-for": it is the emergent intersection of a technology ("thing") with a usage category ("for"). Of course, it is one thing to speak of innovations as being emergent in a general sort of way, but quite another to understand something about the regular rules or "microlaws" that generate emergent structures (Langley, 1999). *The fundamental microlaws of innovation are evaluating, selecting, maintaining, and the auxiliary processes that govern motivation.*

Many systems have been proposed for classifying innovations and numerous typologies have appeared in the literature (see Fagerberg, 2004 for a review.) We may plot some of these by estimating the extent to which their underlying technologies and user motivations are in equilibrium (Figure 65).

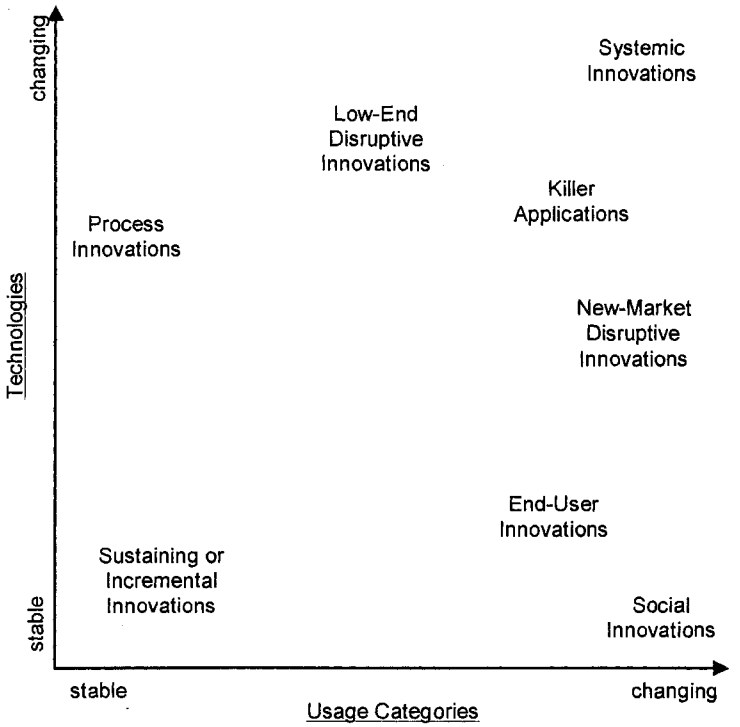


Figure 65. Innovation Types

The novelty of an innovation stems from changes in its underlying usage categories and technologies; the extent to which these are in equilibrium defines the axes of a two-dimensional basin of attraction. A basin of attraction is a set of states that end up at the same stable equilibrium point or *attractor*. A *repellor* is an unstable equilibrium from which all nearby trajectories are forced. The basin of attraction for innovations manifests itself as a gradient that converges toward stability over time (see Figure 66). This is why so many innovations are of a sustaining or incremental nature.

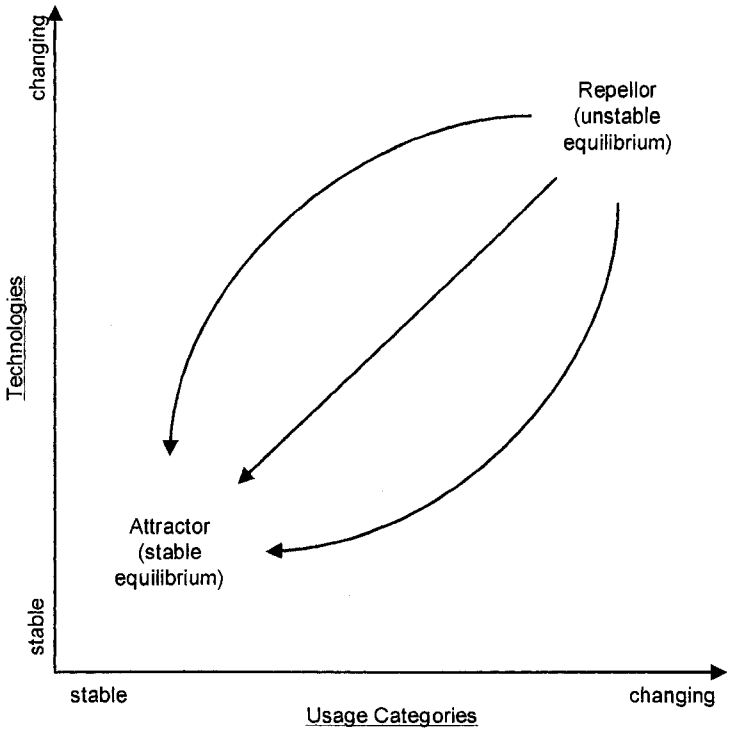


Figure 66. Basin of Attraction for Innovations

Innovations will always act in surprising ways because emergent behavior cannot be anticipated simply through an inspection of their microlaws. To gain an understanding of innovation dynamics we must embody these microlaws in simulated consumer agents.

One of the great advantages of agent-based simulation is that it explicitly takes the spatial dimension into account (see Section 3.1.3.) The spatial dimension need not involve physical topography; it can be a pure abstraction, like a social network or basin of attraction. Thus, it would be very useful to derive a gradient map or response surface of Figure 66 from empirical data. Armed with such a map, an artificial market simulation could be constructed in which agents representing innovations move and interact in the basin of attraction to simulate the dynamics of high-technology markets

and enable qualitative prediction of future market states. For example, the fractal structure of usage categories suggests that consumer populations bifurcate into asymmetric market segments along recurring fault lines (Abbott, 2001). By examining historical market data, it should be possible to identify fault line candidates and simulate the emergence of niche markets. These qualitative market predictions could then be used to help guide organizational strategy.

At this point the basins of attraction for innovations can only be described in general terms, but by analyzing historical data on the emergence of innovations it should be possible to construct a gradient map or response surface of Figure 66. Projects such as TRIZ and the Atlas of Technological Advance (van Wyk, 2007) could be useful in this regard. Christensen's work on low-end and market-disrupting innovations (Bower & Christensen, 1995; Christensen, 1997; Christensen & Raynor, 2003) and Downes and Mui's work on killer applications (Downes & Mui, 1998) also hint at some of the underlying forces and properties that shape the basin of attraction for innovations: How stable is the basin? Which factors determine how fast innovations migrate and interact? How often do new innovations emerge, and from what portion(s) of the basin? Are there characteristic paths that innovations follow through the basin? Do the basins vary from industry to industry?

Thus, by explaining the microlaws of innovation, *this study lays the foundation for an entirely new approach to technology and market forecasting.* However, basic research is needed before a proof of concept demonstration may be conducted.

10.2.6. Integrate Knowledge from Other Fields

A particular strength of this research is the deep insight it has afforded into the nature of adoption. Past DOI research has emphasized the inputs and outputs of adoption without examining the process itself (Eveland, 1979) and has largely ignored decision psychology (Gatignon & Robertson, 1991; Kottonau et al., 2000). *The MTB framework is the first theory to explain the inner mental processes of adoption.* It presents a coherent, empirically grounded, and theoretically integrated framework for adoption that breaks the stagnation of CAPT in a manner analogous to how cognitive psychology broke free of the behaviorist paradigm during the 1960s.

In decision psychology, research on individual decision-making has been dominated by experimental studies of subjects in controlled laboratory settings. These studies have made many important and useful contributions. However, with the notable exception of Beach and Mitchell's Image Theory (1996), there have been few attempts to synthesize a unified theory of decision making. As a result, the decision psychology literature contains a plethora of theories of limited scope that are applicable to specific phenomena such as tradeoff heuristics, attribution, framing, closure, option screening, dominance structuring, regret, and so forth. This study makes a contribution by *combining existing theory with original field research to synthesize an integrated framework for decision making.*

10.3. Methodological and Substantive Contributions

Historically, the social sciences have not fully appreciated the value of software as an analytical tool in its own right (Meyer, 1997, pg. 148). Part of the

problem is that simulation modeling has been viewed as a 'black box' in which practically any desired result may be obtained simply by tweaking assumptions buried deep in the model. This study makes a significant methodological contribution by demonstrating how *qualitative field research can be combined with agent-based simulation modeling to construct consumer agents that are grounded in an unbroken chain of empirical evidence*. The approach taken here could address many weaknesses in the specification, calibration, analysis, publication, and replication of ABSS.

Axtell (2003) argues that a coevolution is currently taking place between social science and software engineering, and that computer simulation is destined to become a major method in the social sciences. This study demonstrates that software has an analytical value that is entirely independent of its usefulness in providing operating instructions to computers. In particular, it has shown how *UML can be combined with grounded theory and sequence analysis* to improve the conceptual clarity of inductively-derived theories, reveal hidden relationships, generate new questions for data collection and analysis, and keep qualitative inquiry focused along productive lines. By enabling grounded theories to be more easily rendered as executable simulation models, this study facilitates the use of agent-based social simulation as a venue for testing and eliminating weak social science theory.

Finally, this study makes a substantive contribution by *developing a GAM that is well-suited to guide the construction of simulated consumer agents*. With the addition of a suitable script-language interface (as described in Chapter 9) this model could be customized to model any Svenson Type III/IV adoption decision. Planned

future work will construct a companion questionnaire to the MTB framework and thereby increase the substantive contribution of this research.

10.4. Concluding Remarks

When I first began working on what would eventually become the MTB framework, I thought of adoption in fairly conventional terms: as a process, an event, and/or a state of being. Having grappled with the adoption concept for the past seven years, I have come to recognize that this phenomenon is deeper and more complex than I originally suspected. My intellectual journey began with software engineering, systems science, and technology management, led me through the social and behavioral sciences, and finally extended into obscure corners of neuropsychology, philosophy, cognitive science, artificial intelligence, animal behavior, and even theology.

I read somewhere that a thesis topic should provide enough 'daylight' to enable a significant contribution to be made, and enough 'heft' to sustain one's interest during the long intellectual and emotional ordeal of completing a doctorate. Adoption has certainly done that, and more besides. At its most basic level, the MTB framework represents my poor attempt to understand how thought is constructed and organized. I feel I have barely scratched the surface of this rich, profound, and endlessly fascinating phenomenon.

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APPENDIX A. RECRUITING FLYERS

PSU Faculty & Staff

Win a $20 Gift Certificate from Powell's Books!

Commuter Decision Making Study

I'm a PSU doctoral student studying how people make commuting decisions. My research will be used to develop a computer model of the adoption process.

If you:

- Are a member of the PSU faculty or staff,
- Are thinking of participating in PSU's **Passport Plus** transit program, or began using **Passport Plus** for the first time within the past year, and
- Have owned or operated a car within the past year,

...then I'd like to talk with you by phone for about 10 minutes to ask you a few questions about your experiences with the **Passport Plus** program. These questions are not expected to touch on any sensitive or uncomfortable topics, and your responses and personal data will be kept confidential.

If you meet the above criteria and participate in a phone interview, you will be entered in a drawing for ***a $20 gift certificate from Powell's Books!***

Research Study: (503) 282-6822
bcapps@hevanet.com

Bike Commuters

Win a $20 Gift Certificate from Powell's Books!

Commuter Decision Making Study

I'm a PSU doctoral student studying how people make commuting decisions. My research will be used to develop a computer model of the adoption process.

If you:

- **Are thinking about riding your bike to work next winter,**
- **Haven't previously ridden your bike to work during the winter, and**
- **Don't work for PSU,**

...then I'd like to talk with you by phone for about 10 minutes to ask you a few questions about your bicycle commuting experiences. These questions are not expected to touch on any sensitive or uncomfortable topics, and your responses and personal data will be kept confidential.

If you meet the above criteria and participate in a phone interview, you will be entered in a drawing for ***a $20 gift certificate from Powell's Books!***

Research Study: (503) 282-6822
bcapps@hevanet.com

Figure 67. Recruiting Fliers

APPENDIX B. TELEPHONE PRESCREENING SCRIPTS

B.1. Prescreening Script – PP+ Case

Opening Statement.

I'd like to thank you for calling about my research study. I know you're very busy and I appreciate your willingness to help me out with my research.

A little bit of background about this study: My name is Brent Zenobia, and I am a Ph.D. candidate in Engineering and Technology Management at Portland State University. I'm conducting a study on how people make decisions about adopting new technologies. The main contribution of my study will be a computer model of the adoption process for green technologies like bicycles, car sharing, and mass transit.

I'd like to ask you a few questions about your daily commute that should take about 20 minutes to complete. Do you have any questions or concerns at this point?

Automobile Use.

Q1. Okay, let's get started then. Have you owned or operated a car within the past year?

If no, skip to closing statement B.

Contact Information.

Next I need to get your contact information. I won't disclose this data to anyone else.

Q2. What is your name?

Q3. Are you a member of the PSU faculty or staff?

If no, skip to closing statement B.

Q4. What is your telephone number?

Q5. What is your mailing address?

Q6. What is your e-mail address?

Personal Innovativeness.

Q7. People have a wide range of attitudes when it comes to trying new technologies. I'm sure you know some people who want to try new technologies as soon as they come along, others who like to wait and see, and others who just aren't interested in trying new technologies. On a scale of 1 to 5, with 5 being very interested in

trying new technologies and 1 being not at all interested in trying new technologies, how would you rate your attitude toward trying new technologies?

CBAM Classification.

Q8. Next, I'd like to ask you a few questions about how you get around town. I'm going to use the term 'commute,' and by 'commute' I mean getting to work, going to school, running errands, doing your shopping, picking up your kids, or just otherwise going about your daily life. PSU offers a commuting package to its faculty and staff called Passport Plus. This program consists of an all-zone TriMet pass, free Flexcar usage during business hours, or reduced-rate campus parking in any combination. Have you ever used Passport Plus as part of your commute?

If no, skip to Q15.

Q9. When did you first begin your participation in the Passport Plus program? Was it more than a year ago, about a year, or less than a year?

If more than a year, skip to closing statement B.

Q10. Do you use your pass only to commute to campus, or do you also use it to go to off-campus places as well?

Q11. a. On average, how often do you use your pass to obtain reduced-rate campus parking? More than once a week, about once a week, or less than once a week?

b. On average, how often do you use your pass to ride TriMet? More than once a week, about once a week, or less than once a week?

c. On average, how often do you use your pass to borrow a Flexcar? More than once a week, about once a week, or less than once a week?

Q12. Do you ever coordinate your TriMet or Flexcar use with other people, such as to go shopping or attend sporting events?

Q13. Have you ever encouraged other people to use TriMet, Flexcar, or Passport Plus?

Q14. Are you looking for ways to get more mileage out of your Passport Plus pass?

Skip to closing statement A.

Q15. Do you have any plans to participate in Passport Plus in the future?

If no, skip to Q17.

Q16. Have you set a date when you plan to begin participating in the program?

Q17. Are you at interested in learning more about Passport Plus?

If no, skip to closing statement B.

Q18. Are you actively seeking information on the program, or are you monitoring information that happens to come your way?

Closing Statement A.

This concludes our telephone interview. I'll enter your name in the drawing for a $20 gift certificate from Powell's Books.

Based on our conversation, you qualify for the next stage of my research study. I'd like to meet with you in person to learn more about how you make commuting decisions. Your participation in this next stage is completely voluntary. If you'd like to participate, I'll enter your name into a pool. A couple of weeks from now I'll draw some names from the pool at random for a face-to-face discussion at a mutually convenient time and place. This discussion will take about an hour and focus on how you make decisions about commuting. It's not expected to touch on any topics which might be sensitive or uncomfortable for you. If your name is drawn, I'll send you an information packet in the mail containing a consent form and a short questionnaire to be completed before the interview. As a thank-you for participating in an interview you'll receive a free pedestrian safety light. Would you be willing to meet with me in person to discuss how you make commuting decisions?

If no, skip to Closing Statement B.

Okay, I'll enter your name in the pool. If you're selected, you should hear from me in a few weeks. In the meantime, if you have any questions or concerns about this study you can reach me at this telephone number. Thank you for your time, and goodbye.

Closing Statement B.

This concludes our telephone interview. Thank you for your time, and goodbye.

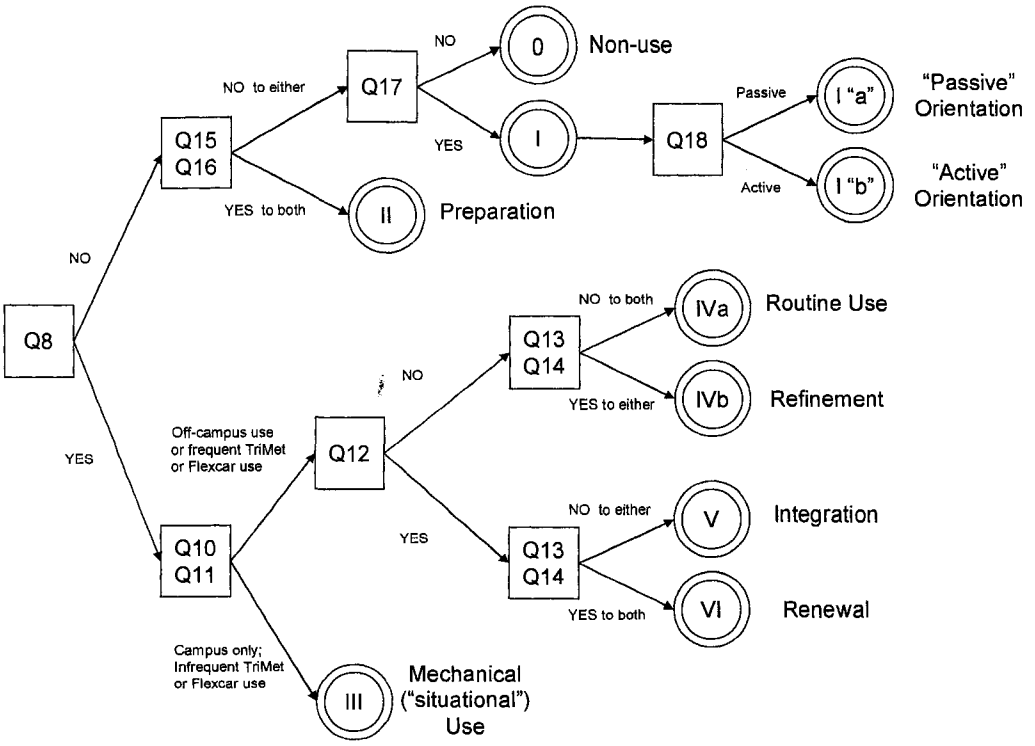


Figure 68. CBAM Classification Instrument – PP+ Case

B.2. Prescreening Script – WB Case

Opening Statement.

I'd like to thank you for taking the time to participate in my research study. I know you're very busy and I appreciate your willingness to help me with my research.

A little bit of background about this study: My name is Brent Zenobia, and I am a Ph.D. candidate in Engineering and Technology Management at Portland State University. I'm conducting a study on how people make decisions about adopting new technologies. The main contribution of my study will be a computer model of the adoption process for green technologies like bicycles, car sharing, and mass transit.

I'd like to ask you a few questions about bicycling commuting that should take about 10 minutes to complete. Do you have any questions or concerns before we begin?

Bicycle Use.

Q19. Okay. I'd like to begin by asking you a few questions about how you get around town. I'm going to use the term 'commute,' and by 'commute' I mean getting to work, going to school, running errands, doing your shopping, picking up your kids, or just otherwise going about your daily life. Do you use a bike as part of your commute?

If no, skip to Q3.

Q20. Do you ride year round, or only when the weather is good?

If year-round, skip to closing statement C.

Q21. Are you thinking of trying to commute by bike during the upcoming winter?

If no, skip to closing statement C.

Contact Information.

Next I need to get your contact information. I won't disclose this data to anyone else.

Q22. What is your name?

Q23. What is your telephone number?

Q24. What is your mailing address?

Q25. What is your e-mail address?

Q26. Where are you employed?

If PSU, skip to closing statement C.

Q27. Approximately how many people work there? Is it more than 50 people, about 50 people, or less than 50 people?

Automobile Use.

Q28. Have you owned or operated a car within the past year?

Personal Innovativeness.

Q29. As you know, people have a wide range of attitudes when it comes to trying new technologies. I'm sure you know some people who want to try new technologies as soon as they come along, others who like to wait and see, and others who just aren't interested in trying new technologies. On a scale of 1 to 5, with 5 being very interested in trying new technologies and 1 being not at all interested, how would you rate your own attitude?

CBAM Classification.

Q30. Now let's return to the topic of bicycles. Do you own a bike at present?

If no, skip to Q18.

Q31. Do you use your bike only to get to work, or only for recreation, or both?

If recreation only, skip to Q19.

Q32. a. On average, about how often do you ride your bike to work when the weather is *good*? More than once a week, about once a week, or less than once a week?
b. On average, about how often do you ride your bike to work when the weather is *cold*? More than once a week, about once a week, or less than once a week?
c. On average, about how often do you ride your bike to work when the weather is *rainy*? More than once a week, about once a week, or less than once a week?

Q33. Have you ever participated in any bicycling community events like a race, Pedal Palooza, a Critical Mass ride, or things of that nature?

Q34. Have you ever encouraged other people to commute by bicycle?

Q35. Do you plan to increase your bicycle use during the coming year?

Skip to closing statement A.

Q36. Do you have plans to purchase a commuter bike?

If no, skip to Q20.

Q37. Have you set a date when you intend to begin riding your bike to work?

Q38. Are you interested in learning more about bike commuting?

If no, skip to closing statement B.

Q39. Are you actively seeking information about bike commuting, or are you monitoring information that happens to come your way?

Skip to closing statement B.

Closing Statement A.

Okay, I'll enter your name in the drawing for a $20 gift certificate from Powell's Books.

Based on our conversation, you also qualify for the next phase of my research study. Participation in this next phase would be entirely voluntary. What I would like to do is to with you in person to gain a better understanding of how your commuting decisions unfold over time. To do that, I'm looking for some bicyclists who will let me talk to them over the winter so I can understand the decision from their point of view. If you decide to participate, I would meet you for two face-to-face discussions. The first time would be in either September or October, and the second time would be in either December or January. Each discussion would last about an hour and would take place at some mutually agreeable time and place. These discussions would focus on how you make decisions about bicycle commuting. They're not expected to touch on anything which might be sensitive or uncomfortable for you. Participation would be voluntary, and you may leave the study at any time. You're under no obligation

to keep riding your bike all winter, and you can still participate in the study even if you decide to stop riding your bike. As a thank-you for participating, you'll receive a free pedestrian safety light with each interview. Are you willing to take part in this phase of my study?

If no, skip to Closing Statement C.

Okay, you should hear from me in early autumn. Prior to our first interview I'll send you an information packet containing a consent form and a short questionnaire to be completed before the interview. Do you have any questions at this point?

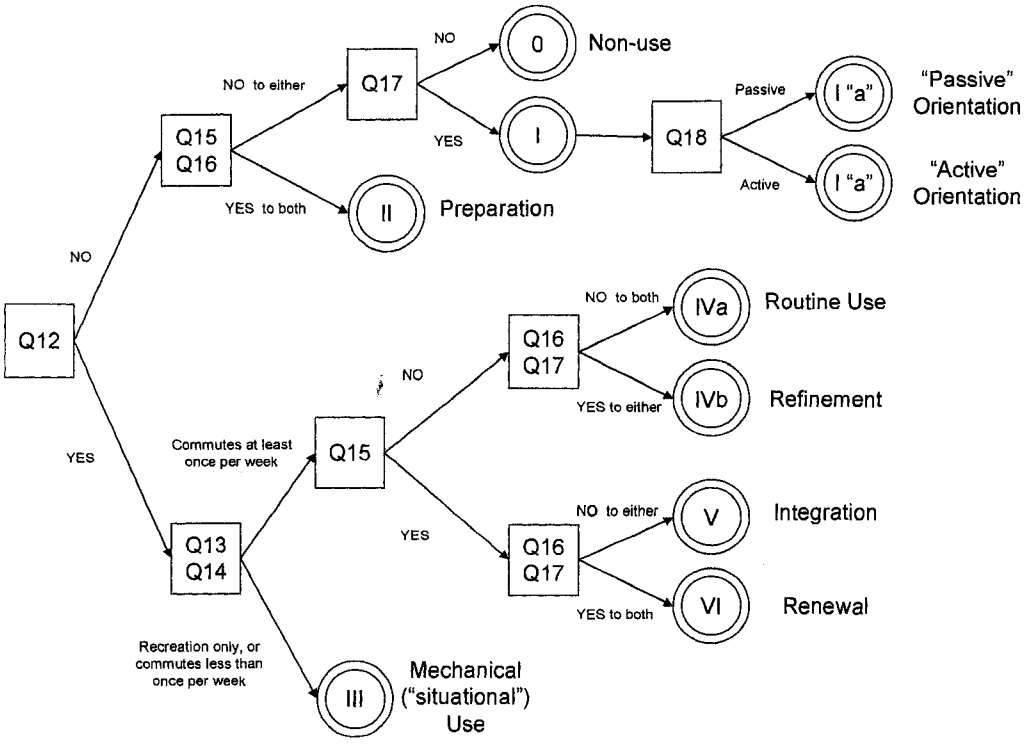
Okay, if any questions or concerns come up for you later on, you may reach me at this telephone number or by e-mail. This concludes our telephone interview. Thank you for your time. Goodbye.

Closing Statement B.

This concludes our telephone interview. I'll enter your name in the drawing for a $20 gift certificate from Powell's Books. Thank you for your time. Goodbye.

Closing Statement C.

Okay, this concludes our telephone interview. Thank you for your time. Goodbye.



Note: Due to the selection criteria for this case, only seasonal bicycle users are classified. Year-round bicyclists are screened out by Q2.

Figure 69. CBAM Classification Instrument – WB Case

APPENDIX C. CRITICAL EVENT SHEET

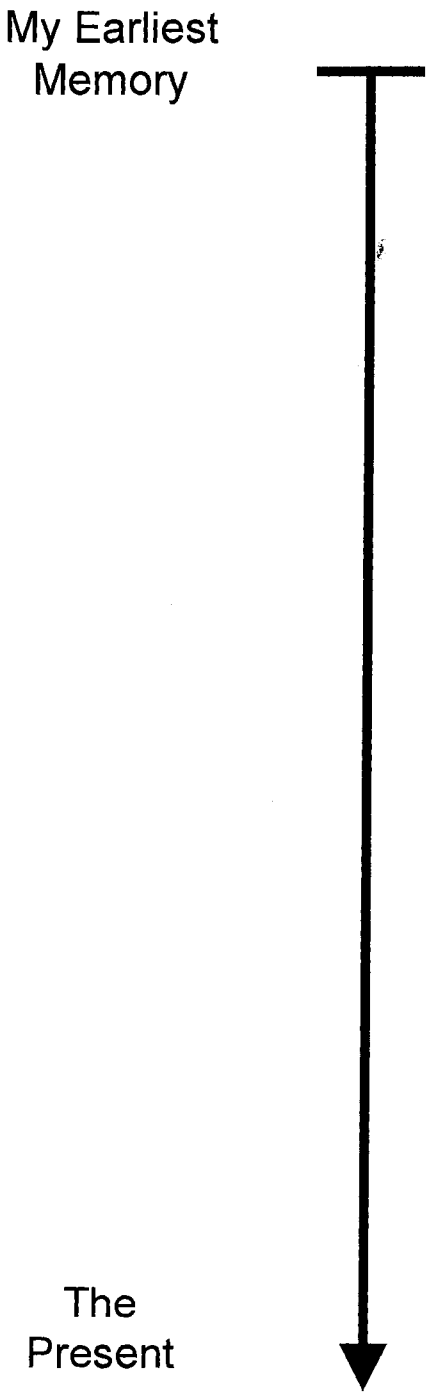


Figure 70. Critical Event Instrument

APPENDIX D. INFORMED CONSENT FORM

This document is being provided to you to help you decide whether or not you want to participate in Brent's research study. It explains what actions are needed from you, as well as the risks and benefits of this research for you and your community. Below are some general questions you might want to ask Brent before you make your decision.

1. Who is Brent? What is his research study about?

Brent is a graduate student in Engineering and Technology Management at Portland State University who is conducting this study as partial fulfillment of the requirements for a Ph.D. degree; he is working under the supervision of his advisor, Dr. Charles Weber. Brent is studying how people make decisions about adopting innovations. The main contribution of his study will be a computer model of the consumer adoption process for green technologies like bicycles, car sharing, and mass transit.

2. Why was I selected to take part in this study?

Brent is interested in talking to adults who are currently considering, or have recently considered, making changes in how they get around town. Brent is looking for folks from all walks of life to help him understand how people make certain kinds of decisions.

3. What will I have to do?

- You will be asked to participate in two interview sessions, each of which will last around an hour. The second interview will take place about two months after the first interview.
- A location will be identified that is convenient for you and accessible for Brent.
- After asking you a few questions about your background, Brent will ask you some questions about how you went about deciding to commute by bicycle this winter.
- With your permission, Brent will audio record the interview. This recording will only be used to help Brent transcribe the interview.

4. What are some risks of participating in this study?

This study poses minimal risk. Brent will not disclose any of your personal data to anyone else. The interview is not expected to touch on topics which might be sensitive or uncomfortable for you. If you don't want to go on, you may stop the interview or leave the study at any time. You're under no obligation to continue riding your bike all winter, and you can still participate in the study even if you decide to stop riding your bike.

5. What are you doing to protect me?

Brent won't tell anyone that you took part in this study. Your name and other confidential information will be omitted from the interview transcripts. The audio records will be kept on file for three years, the amount of time required by federal regulations, and then destroyed. Only Brent will have access to these records.

6. What are the potential benefits of participating in this study?

You will receive a free blinking pedestrian safety light as a gift for participating. You'll receive the light as soon as each interview starts, and it is yours to keep even if you decide to stop the interview. If you would like to receive the results of this study they will be mailed to you at no charge.

7. How can I contact you if I have any questions or concerns regarding this study?

If you have any questions about this study, this form, or the interview, you can e-mail Brent at bcapps@hevanet.com or telephone him at (503) 282-6822. You can also contact the Chair of Human Subjects Committee at Portland State University about your rights as a research participant.

8. How can I contact your advisor and your Graduate Studies Office?

Dr. Charles Weber
Department of Engineering and Technology Management
Portland State University
Post Office Box 751
Portland, Oregon 97207-0751
Phone: (503) 725-8133
E-mail address: charles.weber@etm.pdx.edu

The Office of Graduate Studies
Cramer Hall, Room 117
1721 SW Broadway, Portland, Oregon 97201-0751
Phone: (503) 725-8410 / (800) 547-8887
Fax: (503) 725-3416
E-Mail address: grad@pdx.edu
Hours: 9:00 AM – 5:00 PM

By signing below, I have read and understood the conditions under which I will participate in this study. I give my consent to be a participant and receive a copy of this consent form.

_____ _____

Signature Date

Thank you for taking the time to complete this informed consent.

Best Regards,

Brent Zenobia

Department of Engineering and Technology Management
Portland State University
Post Office Box 751
Portland, OR. 97207-0751, USA

APPENDIX E. INTERVIEW SCRIPTS

E.1. Interview Script – PP+ Case

Collect the consent form and TTM questionnaire; label the questionnaire.

Opening Statement (5 minutes)

Q0: I want to thank you for meeting me today. I know how busy you are and I appreciate your willingness to help me out with my research. As a thank-you for helping, I'd like to give you this pedestrian safety light.

Give the safety light to the informant.

Any comments you make here today will be confidential. I won't be including your name or any other identifying information in my report. I want you to feel that you can speak freely.

While I have some specific questions that I need to ask, mainly my job is to listen and ask you for clarification when I don't understand something. Our time together is limited, so at times I may need to move us along.

Start the voice recorders.

From our phone conversation, I gather that (you've decided / are in the process of deciding whether) to use your Passport Plus pass as a means for getting around town. Today I'd like you to help me understand how your decision unfolded. I'm particularly interested in hearing about the turning points in your decision, and how these related to other problems or concerns that you were experiencing in your life at the time.

Grand Tour Question (10 minutes)

Q1: Let's begin by focusing on the 'big picture'. I have a card here with an arrow across down the page. This arrow represents time, from your earliest memory on this issue down to the present. I invite you to spend a few moments looking back over your decision as a whole to think about what were the most significant happenings or memories that stand out in your mind. Then, when you're ready, take this pencil and mark on the card the approximate time when those memories occurred, and give them labels that you find meaningful. This will help me to keep the sequence of your recollections clear in my mind.

Give the informant the card and a pencil.

Probe 1. What's your earliest memory on this subject? Please mark and label it on your card.

Probe 2. So, after ____, what's the next thing you remember? Please mark and label it on your card.

Estimated number of critical events: 4-5 per respondent.

Mini-Grand Tour Question (10 minutes)

Q2: Okay, let's turn to the (first / next) memory you listed on your card. Tell me more about that.

Probe 1. About how much time had passed since *(the previous event)*?

Probe 2. How did ___ relate to other needs or concerns in your life at this point?

Probe 3. What were some of the options that you were considering at this point? What did you think about them?

Probe 4. Did you encounter any obstacles or distractions?

Probe 5. Is there anything else you'd like to add before we move on?

Repeat mini-grand tour question for each event.

Decision Outcomes (10 minutes)

Q3: That brings us up to the present. What is your overall opinion about Passport Plus at this point?

Probe 1. When do you think you might ride TriMet? When would you not use it?

Probe 2. When do you think you might use Flexcar? When would you not use it?

Probe 3. When do you think you might use your car? When would you not use it?

Closing (5 minutes)

Q4: In summing up, is there anything else you'd like to add?

Q5: Do you know of anyone else who might be interested in participating in this study?

E.2. Interview Script – WB Case (First Round)

Collect the consent form and TTM questionnaire; label the questionnaire.

Opening Statement (5 minutes)

Q0: I want to thank you for meeting me today. I know how busy you are and I appreciate your willingness to help me out with my research. As a thank-you for helping, I'd like to give you this pedestrian safety light.

Give the safety light to the informant.

Any comments you make here today will be confidential. I won't be including your name or any other identifying information in my report. I want you to feel that you can speak freely.

While I have some specific questions that I need to ask, mainly my job is to listen and ask you for clarification when I don't understand something. Our time together is limited, so at times I may need to move us along.

Start the voice recorders.

From our phone conversation, I gather that (you've decided / are in the process of deciding whether) to use your bicycle as a means for getting to work. Today I'd like you to help me understand how your decision unfolded. I'm particularly interested in hearing about the turning points in your decision, and how these related to other problems or concerns that you were experiencing in your life at the time.

Grand Tour Question (10 minutes)

Q1: Let's begin by focusing on the 'big picture'. I have a card here with an arrow across down the page. This arrow represents time, from your earliest memory on this issue down to the present. I invite you

to spend a few moments looking back over your decision as a whole to think about what were the most significant happenings or memories that stand out in your mind. Then, when you're ready, take this pencil and mark on the card the approximate time when those memories occurred, and give them labels that you find meaningful. This will help me to keep the sequence of your recollections clear in my mind.

Give the informant the card and a pencil.

Probe 1. What's your earliest memory on this topic? Please mark and label it on your card.

Probe 2. So, after ____, what's the next thing you remember? Please mark and label it on your card.

Estimated number of critical events: 4-5 per respondent.

Mini-Grand Tour Question (5 minutes)

Q2: Okay, let's turn to the (first / next) memory you listed on your card. Tell me more about that.

Repeat mini-grand tour question for each event.

Bike Challenges (20 minutes)

Q3: That brings us up to the present. What issues have you experienced in terms of...?

Probe 1. ...riding in traffic?

Probe 2. ...health and hygiene?

Probe 3. ...the weather? [Did you procrastinate about getting rain gear?]

Probe 4. ...making the best use of your time?

Probe 5. ...mechanical problems?

Probe 6. ...other people's attitudes about biking?

Probe 7. ...flexibility and integration into all the other areas of your life?

Closing (5 minutes)

Q4: In summing up, is there anything else you'd like to add?

E.3. Interview Script – WB Case (Second Round)

Opening Statement (5 minutes)

Q0: I want to thank you for meeting me again. I know how busy you are and I appreciate your willingness to help me out with my research. As a thank-you for helping, I'd like to give you this pedestrian safety light.

Give the safety light to the informant.

As a reminder, any comments you make here today will be confidential. I won't be including your name or any other identifying information in my report. I want you to feel that you can speak freely.

While I have some specific questions that I need to ask, mainly my job is to listen and ask you for clarification when I don't understand something. Our time together is limited, so at times I may need to move us along.

Start the voice recorders.

I'd like to start out by reading you a recap of our last conversation. Please me know whether it accurately summarizes your situation from last Fall.

Read the case summary.

Grand Tour Question (10 minutes)

Q1: Okay, now let's catch up on your biking experiences since that time.

Probe 1. Did you discover anything that surprised you? How did you deal with it?

Selection (10 minutes)

Q2: How regularly did you ride your bike this past winter?

Probe 1. On any given morning, how did you go about deciding whether to ride?

Probe 2. How did you get around on days when you didn't ride?

Probe 3. Were there periods of time when you did not ride?

Probe 4. Did participation in this study influence your decision whether to ride?

Specific Cycling Challenges (20 minutes)

Q3: Next, I'd like to ask you a series of questions about specific biking issues. Did you experience any challenges in terms of:

Probe 1...riding in the rain for the first time?

Probe 2...riding in the dark for the first time?

Probe 3...riding in the cold for the first time?

Probe 4...riding in the snow? [Alt: How did you get to work that day?]

Probe 5...riding in traffic?

Probe 6...maintenance issues?

Probe 7...health and hygiene?

Probe 8...flexibility and integration into all the other areas of your life?

Probe 9...making the best use of your time?

Probe 10...other people's attitudes about biking?

Probe 11. Did you encounter any other challenges that you had to solve?

Attitude Change (10 minutes)

Q4: In looking back, has your attitude about cycling evolved since last Fall?

Probe 1. Has your attitude toward (cars, TriMet) evolved since last Fall?

Closing (5 minutes)

Q4: In summing up, is there anything else you'd like to add?

APPENDIX F. TTM CLASSIFICATION INSTRUMENT

Please indicate your response to the following questions, with a score of 1 indicating strong disagreement and a score of 5 indicating strong agreement.

	STRONGLY DISAGREE (1)	DISAGREE (2)	NEITHER AGREE NOR DISAGREE (3)	AGREE (4)	STRONGLY AGREE (5)

①	②	③	④	⑤	Q1.	As far as I'm concerned, driving a car is not a problem that needs changing.
①	②	③	④	⑤	Q2.	I think I might be ready to explore ways of driving a car less often.
①	②	③	④	⑤	Q3.	It bothers me to drive so much, and I am doing something about it.
①	②	③	④	⑤	Q4.	It might be worthwhile to find alternative ways of getting around town.
①	②	③	④	⑤	Q5.	It doesn't make sense for me to get rid of my car. I'm not causing a problem.
①	②	③	④	⑤	Q6.	I've already curtailed my driving, but I'm worried that I might find myself suddenly needing a car. I'd like to explore what my options are.
①	②	③	④	⑤	Q7.	I am finally working on driving less.
①	②	③	④	⑤	Q8.	I've been thinking I might want to explore other ways of getting around town.
①	②	③	④	⑤	Q9.	I've been successful at reducing my driving, but I'm not sure I can keep up the effort on my own.
①	②	③	④	⑤	Q10.	At times it is difficult to avoid driving places, but I'm working on it.
①	②	③	④	⑤	Q11.	Filling out this questionnaire is pretty much of a waste of time for me because the problem doesn't have to do with me.
①	②	③	④	⑤	Q12.	I'm hoping that by driving my car less I'll be doing something to help the environment.
①	②	③	④	⑤	Q13.	I guess I'm dependent on my car, but I don't see that as something that really needs to change.
①	②	③	④	⑤	Q14.	I am really working hard to reduce the extent of my driving.
①	②	③	④	⑤	Q15.	Operating a car is expensive, and I really think I should work on reducing my driving.

① ② ③ ④ ⑤ Q16. I tried to reduce my driving, but I'm not following through as well as I'd like. I'd like to find some realistic alternatives to being forced to drive everywhere.

① ② ③ ④ ⑤ Q17. Even though I still use a car, I'm at least working on helping the environment.

① ② ③ ④ ⑤ Q18. I thought once I had freed myself from my car that would be the end of it, but sometimes I still find myself needing a car from time to time.

① ② ③ ④ ⑤ Q19. I wish I had more ideas on how to avoid using a car so much.

① ② ③ ④ ⑤ Q20. I have started driving my car less often, but I would like some help.

① ② ③ ④ ⑤ Q21. Maybe there are options available for driving my car less often.

① ② ③ ④ ⑤ Q22. I may need a boost right now to help me maintain the adjustments I've already made to my driving habits.

① ② ③ ④ ⑤ Q23. Cars may be part of a larger problem, but there's not much I can do about it.

① ② ③ ④ ⑤ Q24. I hope that I can find some good options for driving less often.

① ② ③ ④ ⑤ Q25. Anyone can talk about driving less; I'm actually doing something about it.

① ② ③ ④ ⑤ Q26. All this talk about the environment is boring. People are always claiming the sky is falling.

① ② ③ ④ ⑤ Q27. I'm looking for options to avoid having to go back to driving as much as I used to.

① ② ③ ④ ⑤ Q28. It is frustrating, but I feel I might have to go back to driving more often.

① ② ③ ④ ⑤ Q29. Sure, I drive a car; but so does the next person. So what?

① ② ③ ④ ⑤ Q30. I am actively working on reducing my car use.

① ② ③ ④ ⑤ Q31. I would rather deal with my car and all its petty frustrations than try and live without one.

① ② ③ ④ ⑤ Q32. After all I had done to try to reduce my car use, ever now and again I still find myself needing to use one.

APPENDIX G. INTERVIEW CHECKLIST

What to Bring

1. E-mail reminder
2. Information sheet on informant
3. Safety light
4. DVR + manual + earphones
5. Fresh AAA batteries
6. Interview script
7. Critical event sheets
8. Contact summary sheet
9. Two spare consent forms
10. One spare TTM questionnaire
11. Field book
12. Pens and pencils with erasers; pencil sharpener
13. Backup tape recorder with power pack and tape
14. Business cards
15. Room key or directions/map

Before the Interview

1. Set up backup tape recorder
2. Microphone check of the DVR
3. Collect the consent form; give them a copy
4. Collect and label the TTM questionnaire
5. Give them your business card
6. Give them the safety light

After the Interview

1. Label TTM and Critical Event Sheets
2. Fill out Contact Summary Sheet

Post-Processing

1. DVR: Upload voice recording
2. Scanner: Scan Critical Event Sheet and Contact Summary Sheet
3. Excel: record TTM data, update contact notes, print updated information sheet
4. Word: Create blank transcript file
5. Atlas-TI: attach transcript, crit. event sheet, and contact sheet; create new family
6. Check all files into VSS
7. Run backups
8. File hardcopies

APPENDIX H. CONTACT SUMMARY SHEET

Informant: _____
Contact Date _____ Today's Date _____
Contact Type: Phone Visit E-Mail

1. What were the main issues or themes that struck you in this contact?

2. Summarize the information you got (or failed to get) on each of the target questions you had for this contact.

   Question Information

3. Anything else that struck you as salient, interesting, illuminating, or important in this contact?

4. What new (or remaining) target questions do you have in considering the next contact?

APPENDIX I. UML PRIMER

I.1. Background

This brief introduction to the Unified Modeling Language (UML) is written for social scientists. No prior programming knowledge is assumed.

UML is a visual language for drawing very precise pictures. While these pictures are often used to generate computer code, UML is not a programming language. It is a completely general notation which can be used to diagram any sort of structural or behavioral relationship regardless of whether the intention is to write computer software. For this reason, UML is beginning to find applications in areas which have little to do with computers.

The roots of UML date back to the 1970s, when flow charts and other kinds of diagrams began to be used to design computer software. By the late 1980s so many idiosyncratic notations were in use that the software engineering community needed a uniform standard for drawing precise pictures; UML was the result. The standard is best understood as a collection of many different kinds of diagrams, each of which is useful at conveying a particular perspective. For example, class diagrams are good at conveying the static structure of a system, whereas activity diagrams (the modern equivalent of flow charts) are good at conveying a dynamic flow of tasks.

The standard has been extremely successful and has undergone several revisions since its initial 1997 release; a recent search at Amazon.com listed 4,755 technical and professional books with "UML" in the title. As UML has evolved it has

become richer and vastly more complex. Fortunately, only a tiny fraction of it is needed here.

I.2. The Object-Oriented Paradigm

UML packs a lot of information into a few lines and boxes, so it is important to understand the abstract modeling principles which they represent. The goal of this primer is to convey these modeling principles without leaning too heavily on software engineering jargon. We will use Legos illustrate how UML diagram can be used to document structural and behavioral relationships.

The UML is a standard for object-oriented modeling. An *object* is anything that has identity, structure, and behavior; the Lego on my desk is an object. An object need not be concrete – it can be entirely conceptual. My belief that it will not rain this afternoon could be modeled as an object, as could 'rain', 'afternoon', 'weather', etc. Objects, like words, are abstract representations of phenomena.

A *class* is a family of objects: Lego is a class, but any particular Lego is an object. A class is an archetype or abstraction of essential properties, rather like one of Plato's ideal forms. A class also describes the pattern by which objects of that class are brought into existence or *instantiated* (bearing in mind that these are virtual objects, not physical ones.) It follows that classes embody static structure as well as dynamic behavior.

The UML draws a fundamental distinction between structure and behavior. Structural diagrams are used to define the building blocks of a system (objects and classes), whereas behavioral diagrams are used to show how these building blocks

interact and change over time. In the next sections we will draw upon Lego examples to introduce the five types of UML diagrams which are used in this thesis (see Figure 71).

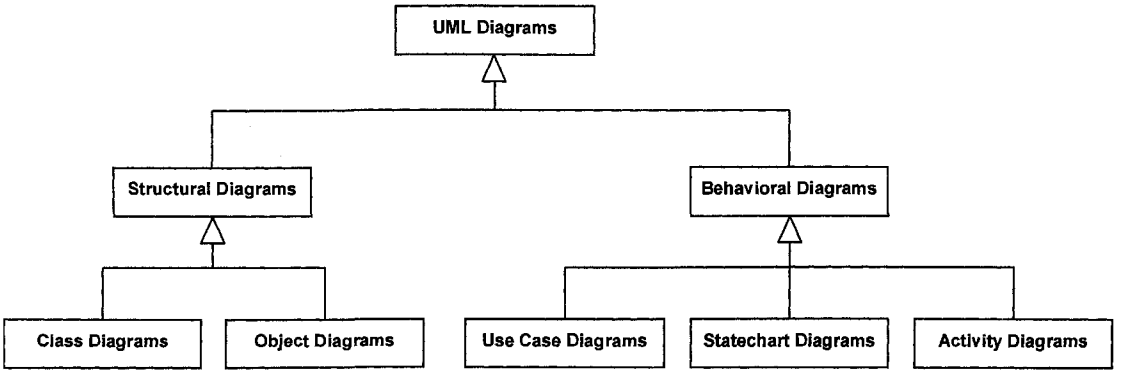


Figure 71. Overview of the UML Diagrams Discussed in this Primer

I.3. Class Diagrams

In UML a class is shown as a box with a name:

Figure 72. UML Classes

The class shown in Figure 72 represents any kind of Lego. Suppose we wanted to list things that were true of all Legos, such as what they are made of or what you could do with them. Two optional compartments are provided for listing the attributes and operations of a class:

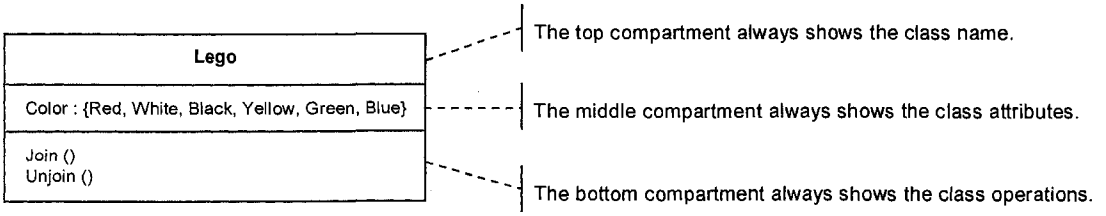


Figure 73. UML Class Compartments

From Figure 73 we see that all Legos have a color attribute and two defined operations, join and unjoin. These properties are automatically inherited by any subclass which is derived from the Lego class. For instance, suppose we wanted to define a particular subclass called a "six-brick" to describe Lego 2x3 bricks:

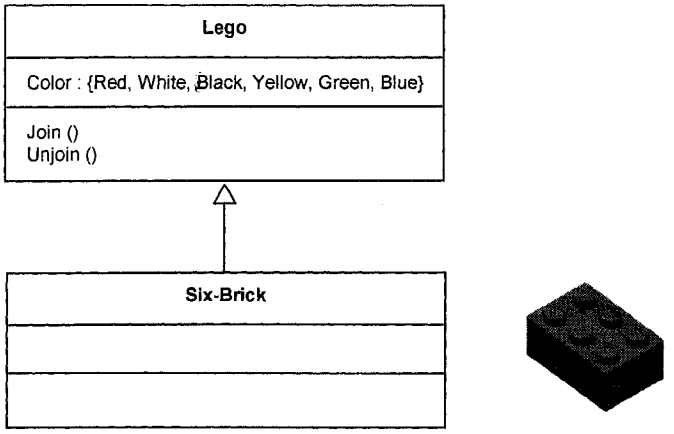


Figure 74. UML Generalization Relationships

Figure 74 tells us that Six-Brick is a type of Lego. In UML a hollow arrow indicates a generalization relationship, which in this case means that Lego is a generalization of Six-Brick. A child subclass automatically inherits the properties of its parent(s), so there is no need to repeat that color, join, and unjoin are defined for Six-Brick; this is implied by the generalization relation. (In UML, the motto is "say it once".)

Nevertheless, we know that there is something distinctive about a Six-Brick above and beyond what Figure 74 is showing us. For instance, we know that a Six-Brick can be joined to as few as zero and as many as six other Legos. This kind of relationship is called an association, and it is indicated by a different kind of arrow:

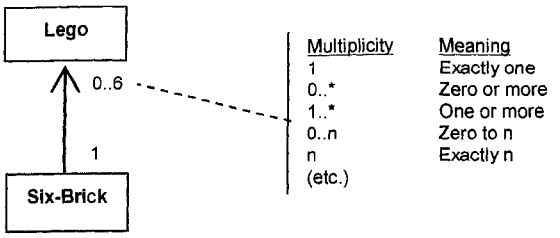


Figure 75. UML Associations and Multiplicity

The 'multiplicity' of the association is such that one Six-Brick can be joined to as many as six other Legos. Notice how Figure 75 omits the attributes and operations defined previously, and does not show the generalization arrow; in UML it is considered good practice to show only the necessary details. This helps to avoid overly complicated and cluttered diagrams. Also, it can be confusing to show both generalization and association in the same diagram, so these relationships are usually conveyed with separate diagrams.

You may have noticed a problem at this point. A Six-Brick can actually be joined with as many as *twelve* other Legos – six with the male pegs and six with the female sockets. Let's clear up this ambiguity:

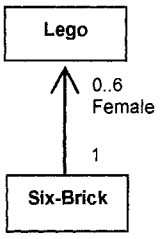


Figure 76. UML Roles

Figure 76 makes it explicit that a Six-Brick can be joined to the female end of as few as zero and as many as six other Legos. "Female" defines a role that one Lego plays in relation to another (i.e., all Legos have sockets, but not every Lego has pegs.) Labeling both ends of the association is unnecessary and would tend to clutter up the

diagram, so following good UML practice we will dispense with the "male" role. Roles are a bit like dummy variables in this sense.

The diagram is still ambiguous because we haven't specified the orientation of the join. Two Six-Bricks can be mated exactly, or they can be offset in a number of ways:

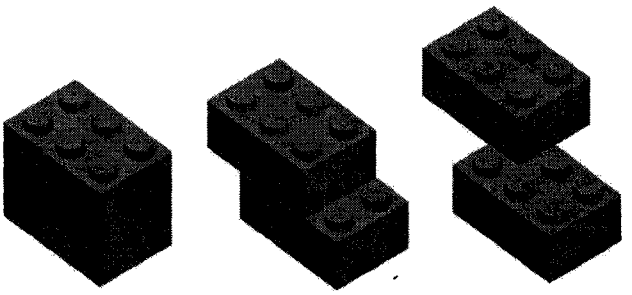


Figure 77. Some Legos

Orientation is not the sole property of either Lego. Instead, it is a property of their joint association. We introduce a new type of class to characterize dyadic relationships:

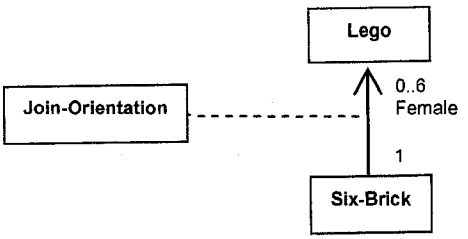


Figure 78. UML Association Class

In Figure 78 the dashed line indicates that Join-Orientation is an association class, a special entity which preserves the properties of the association. A Join-Orientation exists only in relation to the two Legos that it connects; it has no independent existence. Furthermore, if a Six-Brick were to be joined to more than one Lego, like these...

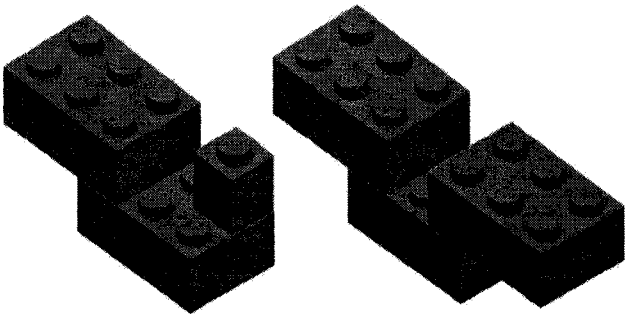


Figure 79. Some More Legos

...then each association would have its own Join-Orientation. A Join-Orientation relates one Six-Brick to one other Lego; the multiplicity of the association indicates how many total instances of Join-Orientation are needed to characterize those configurations.

I.4. Object Diagrams

An object is an instance of a class, and it is created and destroyed by certain operations of that class. Object diagrams are similar to class diagrams except that the names are written differently. Let's take a look at the following configuration of Legos:

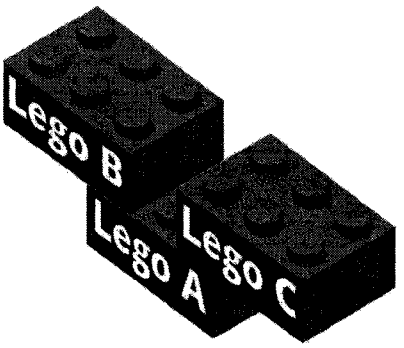


Figure 80. Even More Legos

If we wanted to diagram how *these particular* Legos were connected, we could use an object diagram:

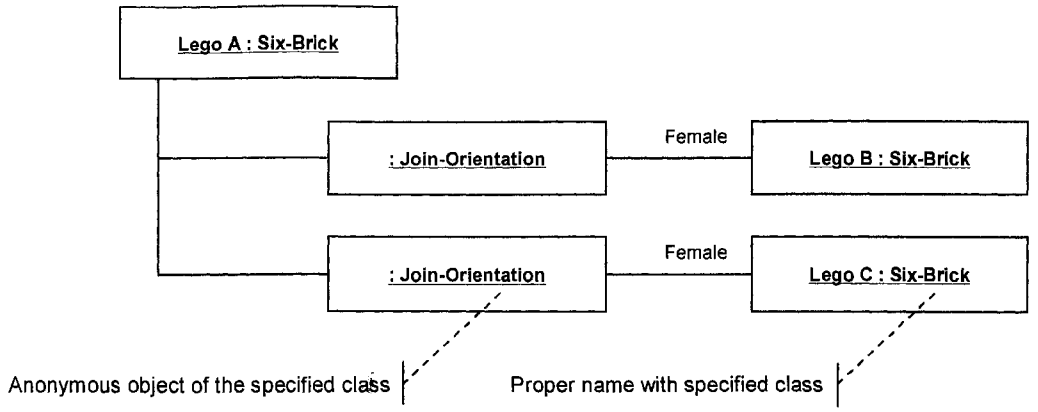


Figure 81. UML Object Diagram

As you can see from Figure 81, there are a couple of different ways of naming objects. Lego A, Lego B, and Lego C are the proper names of three objects of the Six-Brick class. The two instances of Join-Orientation are not important enough for us to give them names; they are anonymous objects. In this thesis, association classes will generally be omitted from the object diagrams to simplify the diagrams and reduce visual clutter:

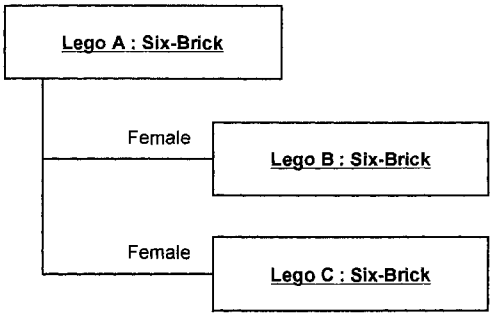


Figure 82. UML Object Diagram (Association Classes Omitted)

I.5. Use Cases

Now we turn our attention to describing how classes interact and change over time. UML includes several types of diagrams which are useful for describing behavior (Figure 71); the first type we shall discuss are Use Case diagrams, which are

helpful for depicting collaboration among the actors and elements involved in some behavioral scenario. Use cases are commonly used as a first step during object-oriented analysis.

It is not possible to illustrate behavior with normal Legos, which are completely static: once assembled, ordinary Legos just sit there. However, Lego makes a kit called a Tankbot which is capable of manifesting behavior[4] and is commonly used to teach basic robotics concepts. It consists of a computer controller and snap-on extensions that can grip objects and sense touch, light, and the rotation angle (see Figure 83.)

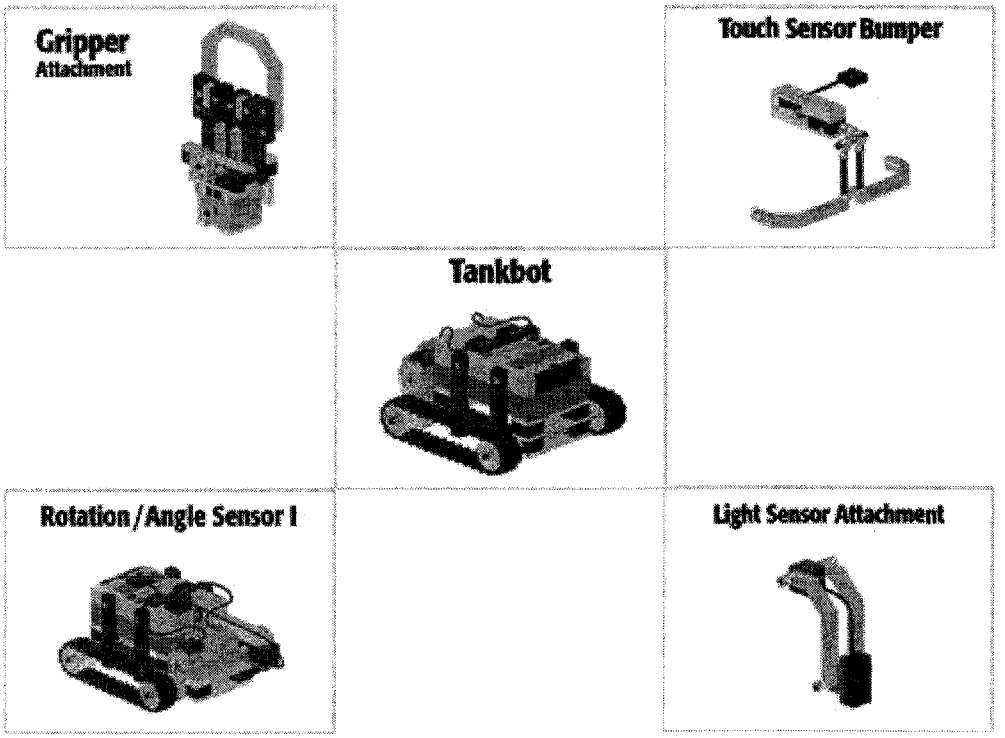


Figure 83. Lego Tankbot and Extensions

[4] While this Tankbot example has a 'mechanical' feel, this thesis will demonstrate that UML is capable of describing psychological as well as mechanical processes.

We will program our Tankbot to count how many black bands ring the inside of a hollow cardboard tube (Figure 84.) The Tankbot will beep its horn each time it passes over a band; when it reaches the far end of the tube it will halt and blink its headlight as many times as there were bands in the tube.

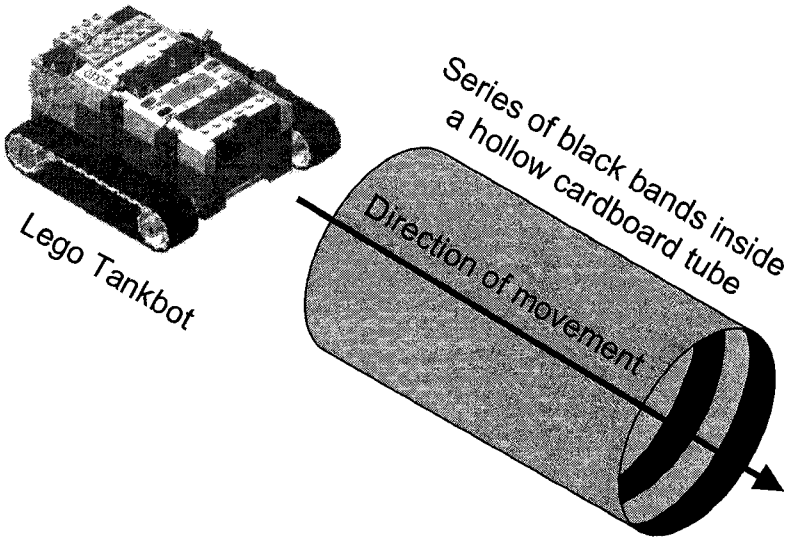


Figure 84. Tankbot Band Counting Scenario

The use case diagram for this scenario is shown in Figure 85.

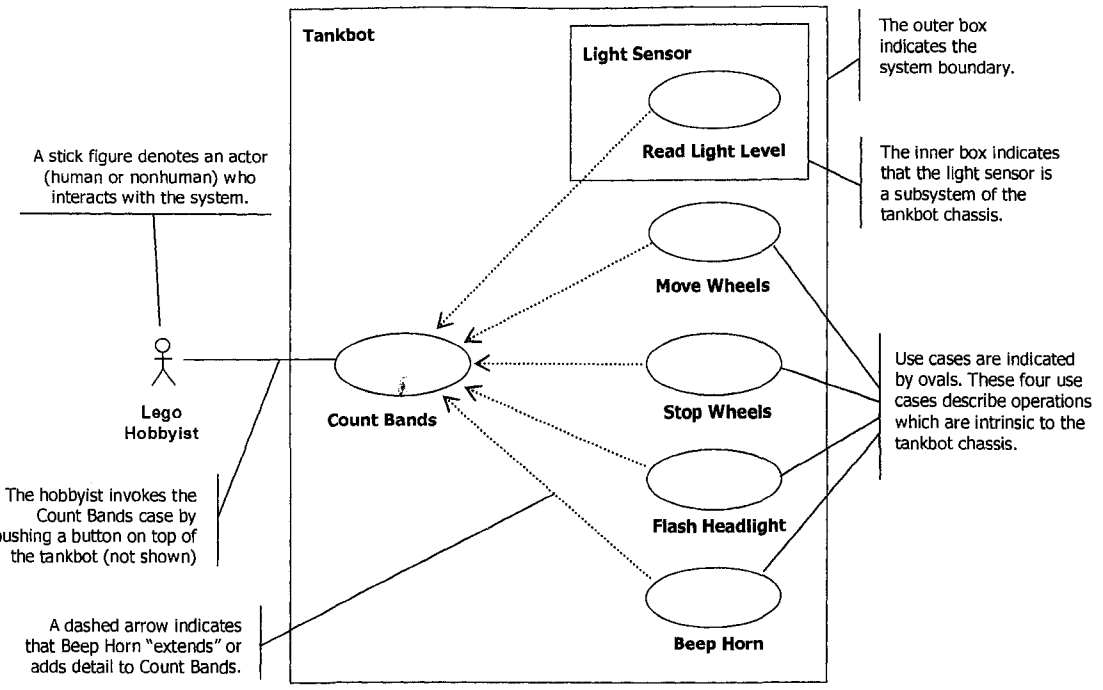


Figure 85. UML Use Case Notation

In Figure 85 an actor – the Lego Hobbyist – sets *Count Bands* into operation by pushing a button. Several subsidiary use cases 'extend' or add detail to *Count Bands*, four of which describe features which are intrinsic to the Tankbot chassis: *Move Wheels*, *Stop Wheels*, *Flash Headlight*, and *Beep Horn*. The fifth case, *Read Light Level*, is available whenever the light sensor subsystem is snapped onto the Tankbot.

I.6. Statecharts

UML Statecharts are useful in describing stimulus/response or event-driven behavior. The light sensor is capable of detecting whether the Tankbot is inside or outside of the tube and whether it is positioned over a black band. Let us define two light thresholds, the first indicating whether the Tankbot is inside the tube and the second indicating whether it is over a black band. If a light level of 100 indicates

maximum brightness and 0 indicates absolute darkness, then we might set the tube detection threshold to 50 and the band detection threshold to 25. We could then describe the relationship among these variables using the Statechart shown in Figure 86.

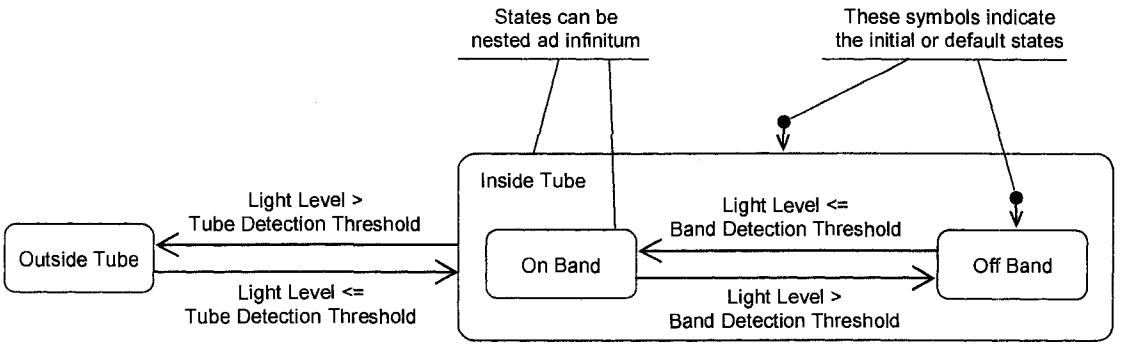


Figure 86. UML Statechart Notation

In some cases action will continue as long as the Tankbot remains in a particular state, such inside the tube; at other times action will occur only when the Tankbot changes from one state to another, such as when it enters the on-band state. It should be noted that the variable which governs the tube state (*Outside Tube* vs. *Inside Tube*) is separate and distinct from the variable which governs the band state (*On Band* vs. *Off Band*), and that in this case the band state is undefined when we are outside the tube.

I.7. Activity Diagrams

UML Activity Diagrams are useful in describing simple behavior in which a system executes a set of tasks until completion or interruption by an external event. *Count Bands* is a simple behavior which is described in detail by the activity diagram in Figure 87.

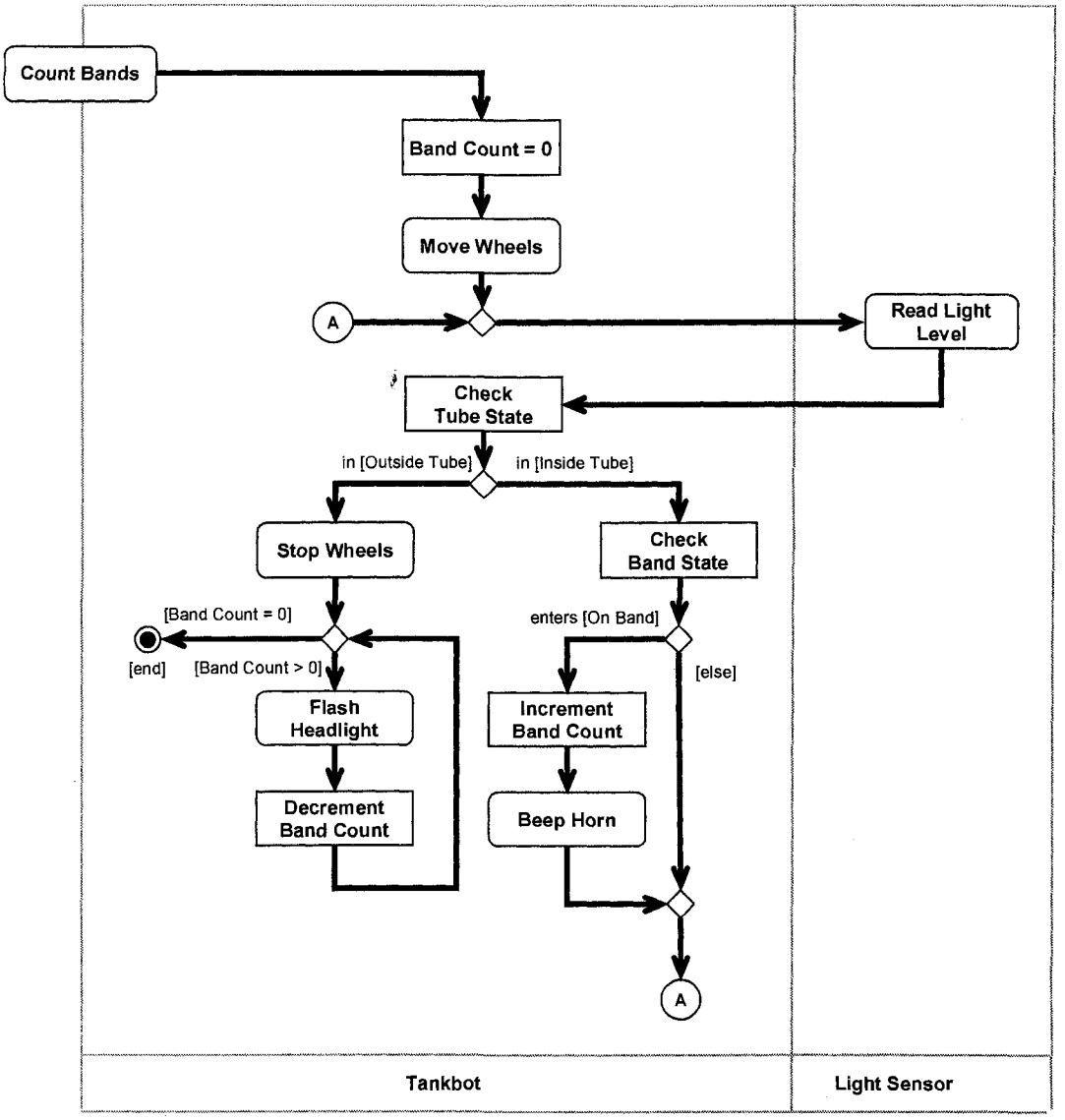


Figure 87. UML Activity Diagram Notation

The Lego Hobbyist sets *Count Bands* in operation by positioning the Tankbot at the entrance to the cardboard tube and pressing the button on top of the unit. The Tankbot sets its *Band Count* variable to zero, begins moving its wheels, and enters a loop. It then reads the light level and consults the statechart in Figure 86 to determine whether it is still inside the tube. If it is, it checks to see if the band-state has changed from *Off Band* to *On Band*, which would indicate that it has detected a new band to be

signified by beeping its horn and add one to the *Band Count*. The Tankbot then loops back to the top of Figure 87 via the label Ⓐ (labels are used to avoid cluttering the diagram with crisscrossing lines.) When the Tankbot detects that it is outside of the tube it halts. As long as its *Band Count* is greater than zero it flashes its light and decreases its *Band Count* by one. When the *Band Count* reaches zero, the operation terminates.

It may be seen by inspection that if the Lego Hobbyist activates *Count Bands* without placing the Tankbot at the entrance to the cardboard tube, the 'bot will immediately detect that it is outside the tube and terminate the operation without beeping its horn or flashing its headlight.

I.8. Lollipop Notation

Finally, we return to class diagrams to introduce one last piece of UML notation which will be very useful in our discussions. Suppose we wanted to express that the Tankbot can connect to other kinds of things than the light sensor:

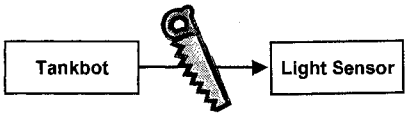


Figure 88. Separating the Tankbot from the Light Sensor

This way of drawing pictures does not seem very satisfactory. From looking at the lower half of Figure 88 it isn't clear who does what, or what kinds of connections are permissible. To solve this problem, UML provides something called "lollipop

notation" which can be used to describe how the Tankbot interfaces with its optional extensions:

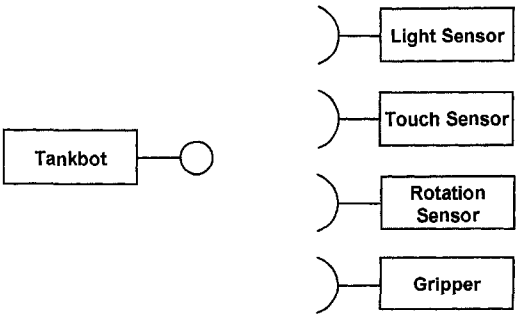


Figure 89. Tankbot and its Extensions in Lollipop Notation

Lollipop notation is useful anytime you want to describe how two modular components interface. The Tankbot can do something even if none of its extensions are attached, but the extensions can't operate unless they are attached to the Tankbot. To show this, we say that the Tankbot *provides* an interface where the extensions can attach, and the light sensor *requires* this interface before it can function (see Figure 90.)

Figure 90. UML Lollipop Notation

Then, when the two ends are mated, they form a contract which specifies their joint behavior.

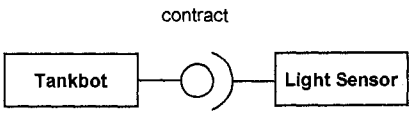


Figure 91. UML Contract

I.9. Additional Reading

A vast number of UML books have been published, only a handful of which are really useful. The most common problems with UML books are a paucity of realistic examples and a dry, abstract, inaccessible style. The works listed here avoid both of these pitfalls. It should not be assumed that the most recent books are best. Some of my favorite UML books are a little outdated now.

All of the following books assume a certain amount of programming expertise. No one has yet written a UML book which is geared to the needs of nonprogrammers.

The best introductory book is UML 2 for Dummies (Chonoles & Schardt, 2003). This book is written by two highly experienced software engineering professionals who explain UML concepts in a very clear, jargon-free way. They alert the reader to a number of tricky conceptual pitfalls in UML. Best of all, they include many useful examples. This book is not only a good introduction, it is one of the best UML books at any level.

A good quick reference book is UML in a Nutshell (Alhir, 1998). This is an older book which does not cover the UML 2.0 standard. Although a newer edition is available from a different author, I prefer the older book; it is better written and far more useful. This book is handy as a quick overview of the UML standard. It should not be taken as an authoritative guide to UML 2.0 notation, but for the simpler sorts of notations that are used in this thesis the older edition is perfectly adequate.

Real Time UML, 3rd Edition (Douglass, 2004) is the best of the advanced books. Although it is certainly not a work for beginners, it does an outstanding job of

presenting UML concepts in a lucid and useful fashion and includes copious examples. If you can only own one advanced UML text, this is the one to have.

APPENDIX J. THE GROUNDED AGENT MODEL

This appendix summarizes the UML diagrams created for the study. The GAM is a conceptual model, and should be considered preliminary until validated by additional field research.

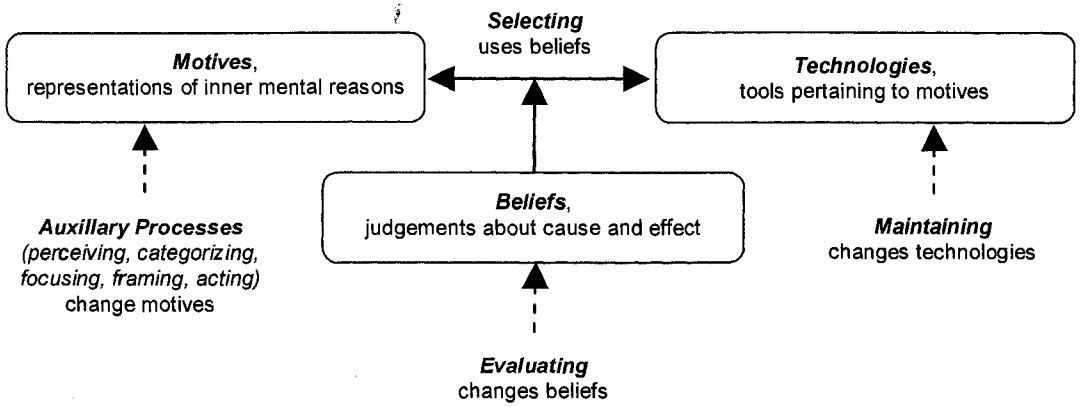


Figure 92. The Motive-Technology-Belief (MTB) Framework

J.1. The Structural Specification

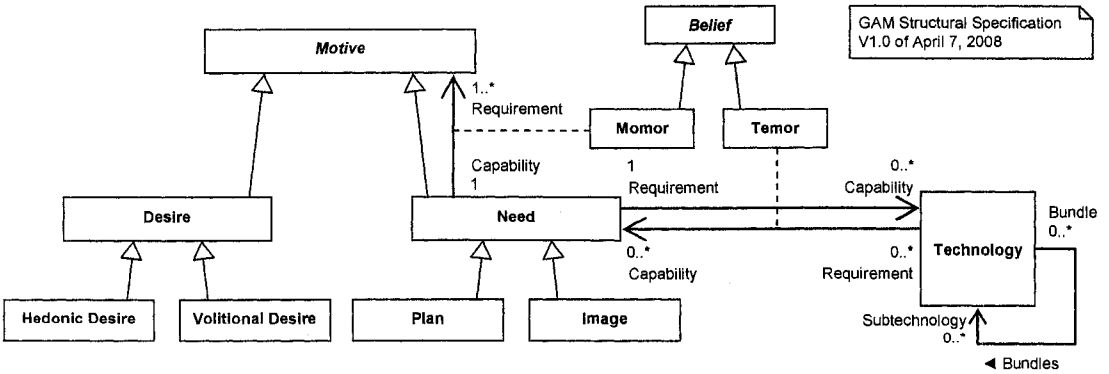


Figure 93. GAM Structural Specification, V1.0 of April 7, 2008

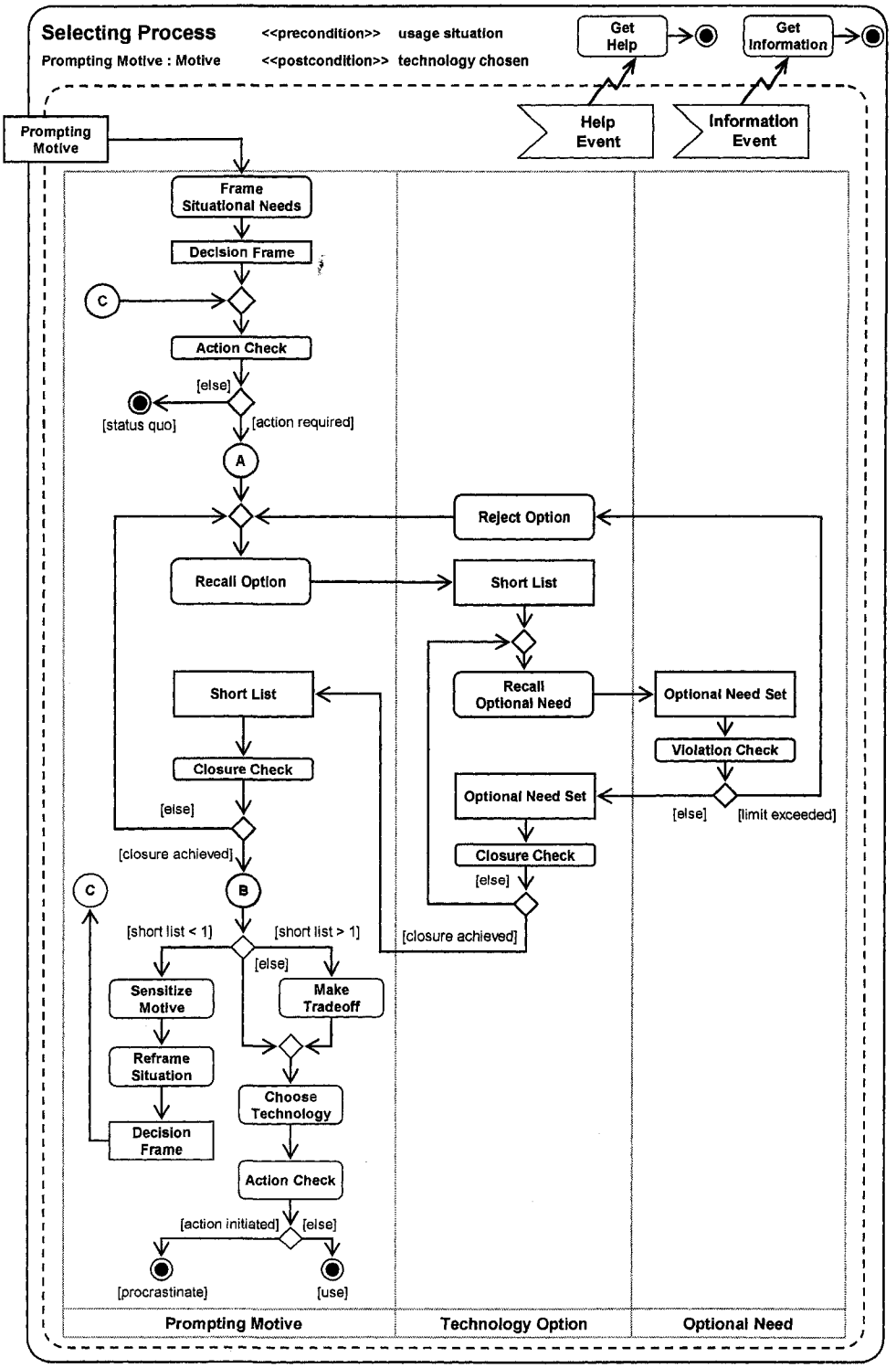


Figure 94. The Need Selecting Process, V1.0 of April 7, 2008

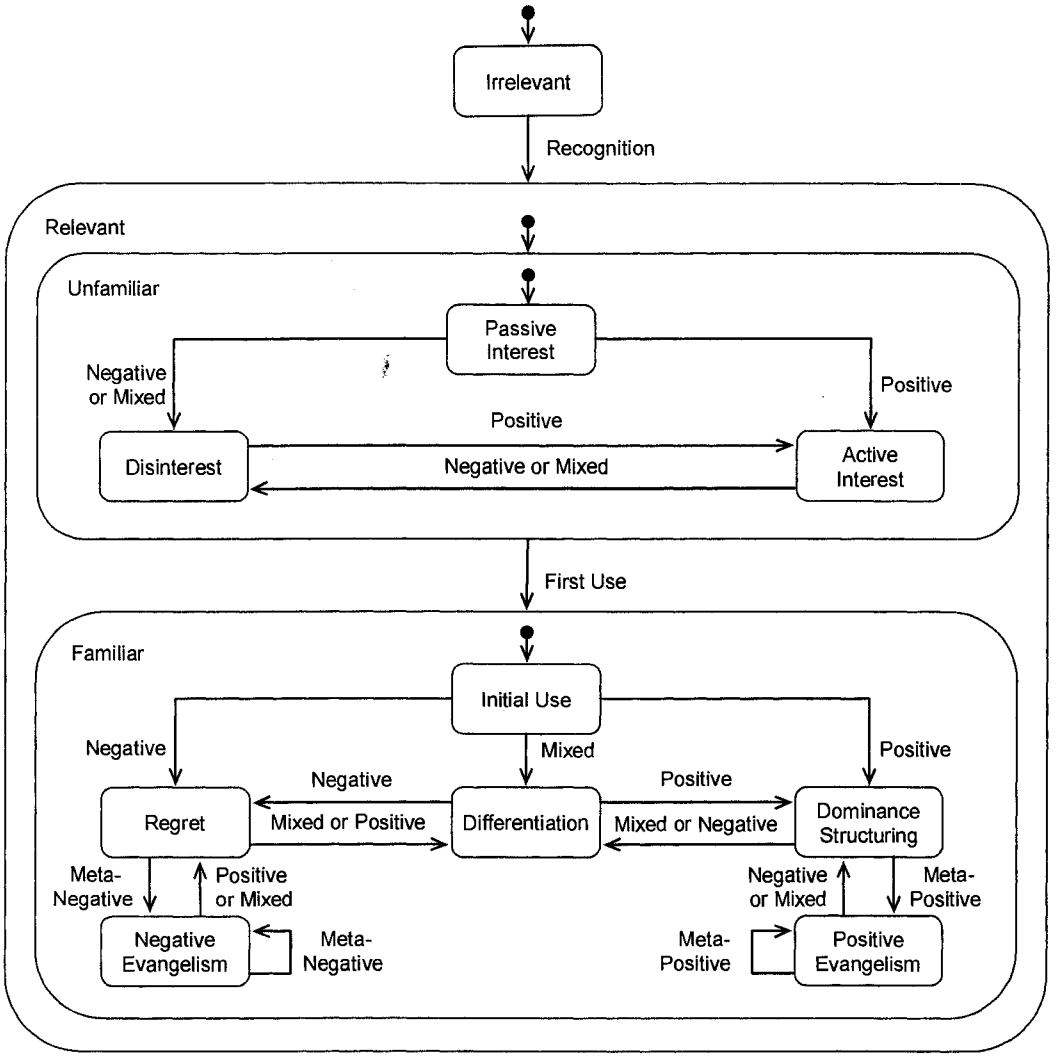


Figure 95. The Temor Evaluating Process, V1.0 of April 7, 2008

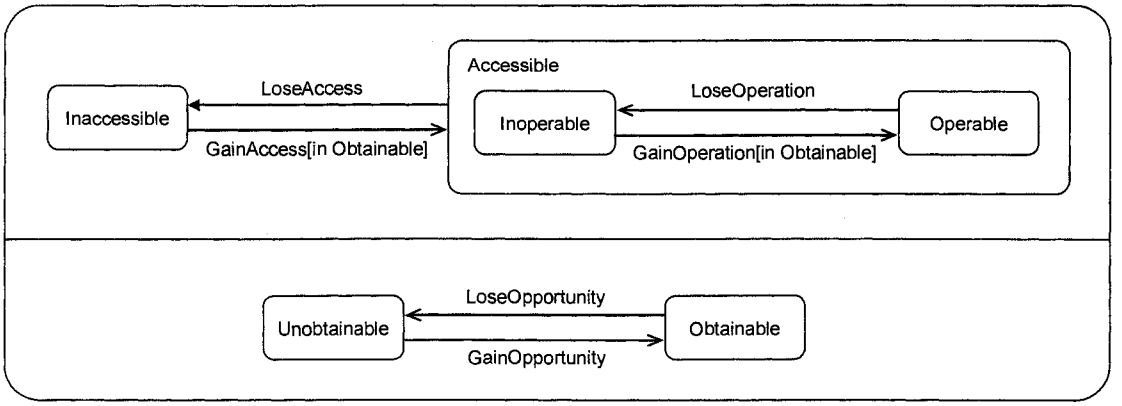


Figure 96. The Technology Maintaining Process, V1.1 of April 22, 2008

APPENDIX K. USE CASES

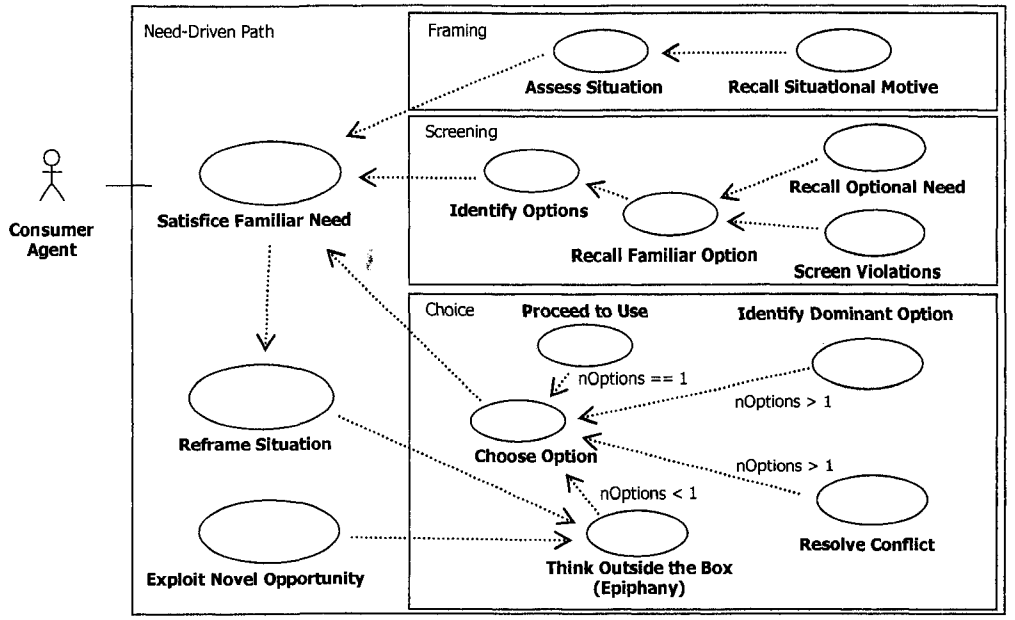


Figure 97. Use Case Diagram for the Need-Driven Adoption Path

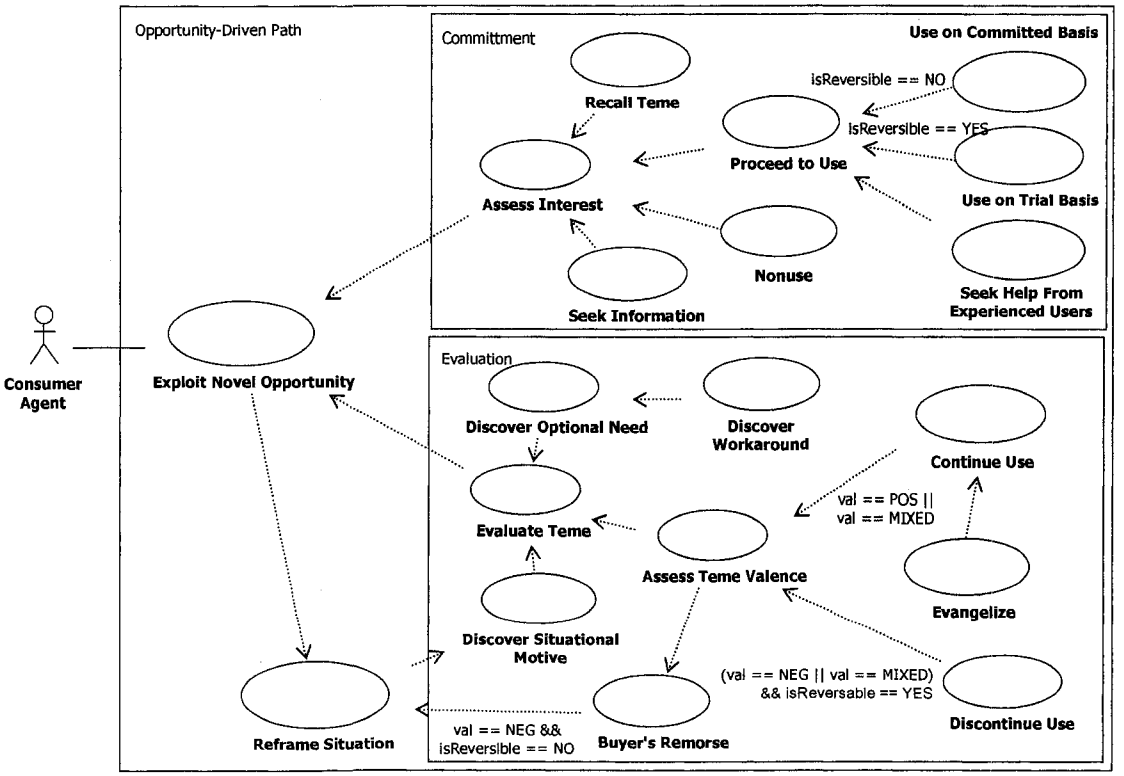


Figure 98. Use Case Diagram for the Opportunity-Driven Adoption Path

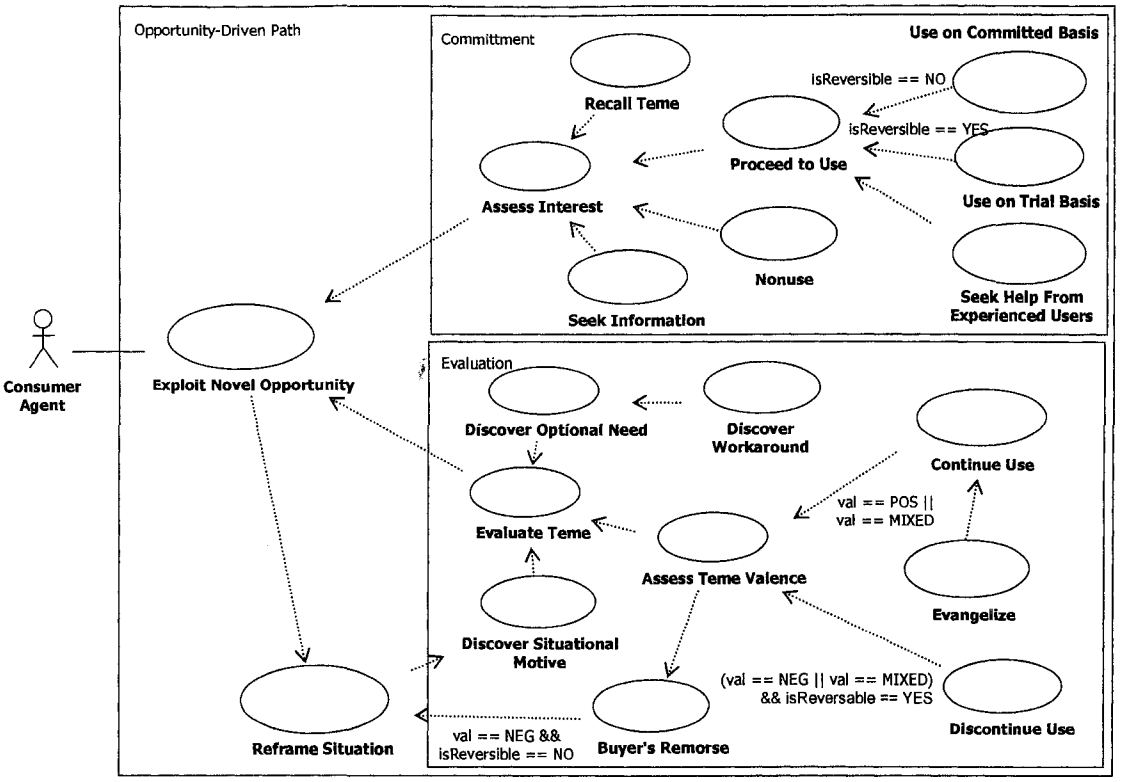


Figure 99. Use Case Diagram for the Problem-Solving Adoption Path

APPENDIX L. INDEX CODES

In Atlas-ti, codes were primarily used to index certain passages in the code for later retrieval. Index codes were not used extensively during analysis; memos were much more important for this purpose. The grounded column refers to the number of quotation links, and density refers to the number of network diagram links.

TABLE 19. INDEX CODES

Code	Grounded	Density	Definition
Candidate, evaluation mixed	20	0	A candidate evaluation episode which the informant perceives as containing both positive and negative aspects
Candidate, evaluation negative	21	0	A candidate evaluation episode which the informant perceives as largely negative in character
Candidate, evaluation positive	32	0	A candidate evaluation episode which the informant perceives as largely positive in character
Candidate, exposure 1st	25	0	Initial exposure to the technology candidate
Candidate, exposure decreasing	3	0	Exposure to the technology candidate is occurring less frequently than before
Candidate, exposure increasing	12	0	Exposure to the technology candidate is occurring more frequently than before
Candidate, interest 1st	15	0	Earliest expression of interest in the technology candidate
Candidate, interest active	20	0	Making an effort to actively seek out information
Candidate, interest decreasing	5	0	The informant's interest in the technology candidate is decreasing (e.g., from active to passive)
Candidate, interest increasing	15	0	The informant's interest in the technology candidate is increasing (e.g., from passive to active)
Candidate, interest lost	5	0	The informant has lost interest in the technology candidate
Candidate, interest passive	17	0	Wait-and-see mode -- passively monitoring information that comes your way
Candidate, need found	7	1	A primary need or perk has been found for this candidate
Candidate, need seeking	17	1	A potentially useful technology candidate has been identified, and a search is currently underway to find some need (a solution chasing a problem to solve)
Candidate, use 1st	29	0	First hands-on use of a technology candidate
Candidate, use block	26	0	Informant is willing to use the candidate, but is being prevented from doing so for some reason
Candidate, use block removed	7	0	Informant had been prevented from using a technology candidate, but the obstacle has now been removed

Code	Grounded	Density	Definition
Candidate, use decreasing	11	0	The informant's use of the technology is decreasing (e.g., from routine to situational)
Candidate, use discontinued	9	0	The informant has ceased to use the technology
Candidate, use increasing	12	0	The informant's use of the technology is increasing (e.g., from situational to routine)
Candidate, use learning	19	3	The informant is learning how to use the technology
Car, biodiesel	1	0	Biodiesel car
Car, electric	0	0	Electric car
Car, Hummer	13	0	Discussions involving Humvees
Car, hybrid	16	0	Hybrid car
Com, $$	104	0	Affordability issues
Com, accessibility	42	1	Issues surrounding the physically accessibility of this technology. Accessibility differs from availability, flexibility, and ease of use in that accessibility pertains to physical or geographical considerations (e.g., handicapped access), whereas availability refers to temporal considerations, flexibility refers to life integration issues, and ease of use refers to the mental demands attending technology use.
Com, availability	57	1	Issues surrounding whether this technology is reliable and available on demand -- where and when you need it. This code also refers to reliability issues (e.g., will I get a flat on my bike?) in the sense of being able to get where you want to go in a timely fashion without unexpected delays. Availability differs from accessibility, flexibility, and ease of use in that availability deals with temporal considerations (e.g., Does the bus run at the time of day when you need it?) rather than geographical or physical limitations, life integration issues, or mental demands attending use.
Com, ease of use	40	3	Issues surrounding whether the technology is easy to use in the sense of requiring much mental effort to operate it. This code is limited to technology use, and thus differs from flexibility (life integration issues), accessibility (physical effort or geographical proximity), and availability (temporal proximity.) This code also differs from familiarity in that something can be hard to use and yet still familiar.
Com, familiarity	18	4	Familiarity with the use of this technology. This code differs from ease of use in that something can be hard to use, yet one may still be comfortable with its use ("It's a little tricky, you have to jiggle the handle to get it to work.")
Com, fatigue	5	0	Physical or mental fatigue which influences the use of this technology ("I'm too tired to ride my bike today", "I'm tired of dealing with the bus", etc.)
Com, fear	22	4	Fears associated with the use of this technology (e.g., dread of some specific bad consequence like missing the last bus and being stranded in the middle of nowhere; generalized fear of the unknown; more specific fears, like getting smacked by a car while running to catch the bus or getting attacked while riding the bus late at night.) It differs from stress as a matter of degree.
Com, flexibility	36	1	Issues surrounding the ability to easily integrate and reconcile the demands of using this technology with the other demands of one's life. Flexibility differs from accessibility, availability, and ease of use in that flexibility refers to life integration issues rather than technology use (e.g., is carpooling going to interfere with my ability to work late tonite?)
Com, health	37	0	This code refers to physical health and wellness considerations attending the commuting experience. This category would also include biking to work in order to get some exercise. It differs from health image in that commuting health refers to immediate physical experience (e.g., my shoulder hurts from riding my bike), whereas health image refers more to one's future hopes and plans (e.g., I want to ride a bike so I can lose some weight.)
Com, hygiene	8	0	Codes related to personal hygiene (e.g., needing to shower after a bike ride)
Com, maintenance	7	0	Codes related to bike maintenance
Com, parking	37	0	Parking hassles (e.g., around the PSU campus)
Com, safety	65	0	Codes related to personal safety which is personally experienced - as opposed to hearsay.
Com, security	3	0	This code pertains to the security of one's possessions (i.e., a bike) as opposed to one's personal safety.

Code	Grounded	Density	Definition
Com, stress	54	1	Stress and anxiety issues surrounding the use of this technology. This code differs from fear in degree; stress refers to hassles (e.g., being a minute late in returning the Flexcar) as opposed to fear of dreadful consequences (e.g., putting one's safety at risk.)
Com, time utilization	96	1	Making the best use of one's time (e.g., figuring out how long it will take to get somewhere; using the bus ride to relax or get some work done.)
Com, weather	38	0	Commuting codes related to weather conditions.
Diffusion, observability	15	0	Codes related to observability as it pertains to technology diffusion
Diffusion, opinion leaders	12	0	Codes related to opinion leadership as it pertains to technology diffusion
Diffusion, technology cluster	9	0	Codes related to interactivity and interdependence among distinct technologies.
Image, arc	28	0	The arc of one's life; image of an ideal future
Image, cool	25	0	Codes associated with coolness, hipness, or trendyness
Image, diversity	8	0	Beliefs and attitudes pertaining to social diversity
Image, freedom	1	0	Beliefs and attitudes pertaining to personal freedom, or the lack thereof. Can also pertain to escapist fantasies
Image, fun	19	0	Codes related to fun, entertainment, and personal enjoyment -- as #5 says, "I just enjoy riding my bike...it just made me feel good about life."
Image, green	43	0	Beliefs and attitudes about "greenness" or environmental consciousness
Image, guilt	20	1	Feelings of guilt -- perhaps stemming from violations of self-image
Image, health	16	0	Beliefs and attitudes about health and wellness issues. It differs from Com, health in that this category is focused more on motivational issues (why you exercise) rather than physical and logistical issues (how you exercise.)
Image, nonconformity	14	0	Codes association with rebellion, counterculture, individualism, or defiance
Image, plan	17	0	Plans or actions for fulfilling one's image of an ideal future
Image, self-reliance	12	1	Codes associated with retaining self-confidence, personal independence, autonomy, and control -- or the lack thereof
Image, shadow projection	8	0	This code refers to the projection of shadow characteristics onto an external group in order to get rid of them from one's self ("Lance Armstrong wannabes")
Image, successful	23	0	Beliefs, attitudes, and assumptions about what it means to be successful (or unsuccessful) in life
Image, values	21	0	Principles of rightness/wrongness
Image, violation	29	2	An act or situation which violates one's ideal self-image
In vivo, commuting	115	0	In vivo codes pertaining to aspects of the commuting experience
In vivo, methodology	1	0	
In vivo, self-image	70	0	In vivo codes pertaining to self-image
In vivo, TADP	19	0	In vivo codes related specifically to innovation adoption.
Limit, count	6	0	A change which occurred because some maximum count was exceeded
Limit, interrupt	5	0	A change which occurred because the process was interrupted by some exogenous event
Limit, procrastination	19	2	Codes related to dithering, dawdling, hemming and hawing, and generally avoiding making a decision at all.
Limit, timeout	12	1	A change which occurred because some time limit was exceeded
Mode, bike	141	0	Bicycle
Mode, bus	110	0	Riding the bus
Mode, car, 1P	83	0	Single-passenger car, typically owner-operated
Mode, car, friend's	10	0	Traveling as a passenger in a car operated by a friend or family member; alternatively, borrowing a friend's car
Mode, car, pool	13	0	Car pooling

Code	Grounded	Density	Definition
Mode, car, share	116	0	Car sharing (e.g., Flexcar)
Mode, ferry	1	0	Taking the ferry (e.g., in San Francisco or Seattle)
Mode, rail	67	0	Light rail (e.g., MAX), streetcar, or heavy rail (e.g., commuter train)
Mode, ski	3	0	
Mode, taxi	9	0	Taking a cab
Mode, walk	17	0	Walking
Need, awareness 1st	12	0	The informant's first awareness of something being needed in a situation
Need, candidate found	11	0	A technology candidate has been found for a previously identified need
Need, candidate seeking	6	0	The informant is aware of a need, and is searching for a technology candidate which satisfies that need (a problem chasing a solution)
Need, conflict	25	4	A technology candidate is potentially useful, but sets up a conflict among the needs in the decision frame.
Need, conflict resolution seeking	26	2	The informant is attempting to resolve a conflict among the needs in a decision frame.
Need, conflict resolved	18	2	The informant has managed to resolve a conflict among the needs in a decision frame.
Need, importance decreasing	4	0	The informant perceives the importance of this need to be decreasing.
Need, importance increasing	10	0	The informant perceives the importance of this need to be increasing.
Need, involuntary	7	1	A need has arisen which the informant derives no benefit from resolving -- only the avoidance of some penalty.
Need, latent	4	1	Needs which have not yet been recognized or consciously acknowledged by the decision maker.
Need, primary	44	0	A primary need is an important need, the criteria which determines the decision outcome.
Need, satisfied	8	0	A technology candidate has been identified which simultaneously resolves all of the needs in a solution frame.
Need, secondary	34	0	A perk is a secondary need. It differs from a primary need as a matter of degree; perks convey relatively minor advantages.
Need, unmet	11	1	A previous search has failed to turn up any viable technology candidates for this need.
Need, unmet resolved	2	1	A technology candidate has been identified for a previously unmet need
PSU, reduced rate parking	16	0	Codes related to reduced rate parking on the PSU campus.
Psy, anchoring & adjustment	3	0	Unconsciously anchoring estimates up or down from an original starting point
Psy, behavioral trap	5	2	Quotes relating to the positive or negative use of psychological commitment
Psy, cognitive dissonance	5	0	Simultaneously holding two inconsistent and conflicting beliefs. Festinger proposed CD as a motivational theory, and argued that CD was triggered in part by public advocacy of a position.
Psy, conformity	3	0	Codes related to pressures to conform to social influence
Psy, discounting	6	2	The tendency to place greater value on rewards which are nearer in time, and discount the value of rewards which are distant in time. See Conflict theory (Lewin 1951, Miller 1944); Construal Level Theory (Liberman & Trope 1998; Trope & Liberman 2000; Sagristano, Trope and Liberman 2002); Prospect Theory (Tversky and Kahneman 1981)

Code	Grounded	Density	Definition
Psy, dominance structuring	15	3	The practice of eliminating or neutralizing violations of dominance by means of editing operations (de-emphasis, bolstering, cancellation, collapsing -- and one might also add learned helplessness to this list.) Svenson distinguishes differentiation and consolidation from dominance structuring largely based on when it occurs -- predecision in the case of dominance structuring vs. postdecision in the case of differentiation and consolidation -- but it's not clear to me that this distinction is truly meaningful.
Psy, framing	14	3	Including a need within the decision maker's conception of the acts, outcomes, and contingencies associated with an episode of technology adoption or selection. Frames are partly controlled by the formulation of a problem, and partly controlled by the norms, habits, and characteristics of the decision maker.
Psy, regret	18	3	Codes associated with regret ("Oh damn, I just missed the bus!") A fair percentage of pedestrian injuries or fatalities occur when they run across lanes of traffic while attempting to catch the bus.
Psy, risk, dread consequences	16	2	Perceived dread risk of future consequences. This category differs from unknown consequences in that it involves visualizing and fixating on the worst possible thing that could happen.
Psy, risk, unknown consequences	7	3	Perceived risk of unknown consequences. This category differs from dread risk in that it doesn't involve visualization of any specific outcome. For example, not knowing how long it will take to commute from A to B using an unfamiliar transit mode.
Psy, selective exposure	6	1	The tendency to attend to information which is consistent with one's existing beliefs and attitudes ("I wouldn't have seen it if I hadn't believed it.")
Psy, selective perception	8	0	The tendency to interpret information in terms of existing attitudes and beliefs ("I won't believe it.")
Q, critical event	192	0	Label associated with critical event sheet
Q, followup	13	0	Followup question for subsequent interviewing
Q, puzzle	5	0	I was struck by the sense of 'What's going on here?'
Q, surprise	23	0	I found this unexpected and surprising
Selection, evoked	49	0	A preferred or routinely evoked option
Selection, inept	38	0	An option which would never be chosen to address this need
Selection, inert	34	0	A latent choice or backup option; may require "thinking outside the box"
Soc, advocacy	11	0	Advocating use of a technology to another person
Soc, community-building	16	0	Deeper and more extensive socializing around technology use. Making plans for socializing that alters plans for technology use; social factors for technology selection override functional factors; constructing a shared identity (sense of "us") around technology use
Soc, conflict	44	0	Codes related to conflict and attempts to resolve conflicts
Soc, socializing	38	1	Episodes of socializing with others while using the technology
TriMet, annual pass	42	0	TriMet's Passport program; also includes PSU's Passport Plus program
TriMet, daily fare	10	0	Normal TriMet fare; also includes day passes and bus tickets.
TriMet, discounted tickets	1	0	
TriMet, Fareless Square	2	0	
TriMet, monthly pass	4	0	Monthly pass
TriMet, Park and Ride	8	0	

APPENDIX M. MEMOS

Memos were a primary instrument for grounded analysis; 160 memos were produced during this study, classified in six categories: ordinary memos, commentaries, meeting minutes, methodology memos, modeling memos, and theoretical memos.

Some memos are more important than others. Excluding minor glosses on the transcripts, memos on the mechanics of Atlas-ti, and meeting minutes, 131 memos were used for analysis; these are listed in Table 20. The grounded column refers to the number of quotation links, and density refers to the number of network diagram links. Memos instrumental to the analysis are included as full text; these are signified by boldface.

TABLE 20. SUBSTANTIVE MEMOS

ID	Page	Memo	Network Diagram	Grounded	Density	Type
		#14 and #18		4	6	Commentary
M.1	302	**Adoption as an equilibrium state**		**1**	**6**	**Theory**
M.2	303	**Adoption as puzzle-solving**		**5**	**18**	**Theory**
M.3	303	**Adoption vs. retention**		**1**	**7**	**Theory**
		"An inflationary aspect to the argument"		2	8	Memo
		Anxiety disorder and the bus		5	12	Commentary
		Are dominance structuring and spin synonymous?		0	1	Theory
M.4	303	**Autogenesis**		**0**	**4**	**Theory**
M.5	306	**Automobiles as addictions/attachments**		**5**	**12**	**Memo**
M.6	306	**Being a grownup**		**3**	**10**	**Theory**
M.7	307	**Being a kid**		**1**	**6**	**Theory**
M.8	307	**Being a professional**		**2**	**5**	**Memo**
M.9	308	**Bicycle adoption as a series of challenges**	N.1, N.5, N.6, N.9, N.10	**11**	**22**	**Theory**
		Bike- and Transit-unfriendly communities		6	7	Memo
M.10	310	**Bike commuting perceptions – novice vs. experienced**	N.1, N.9, N.10	**6**	**14**	**Memo**
M.11	311	**Bike culture vs. mass transit (non)culture?**		**0**	**4**	**Theory**
		Bike routes as fishing holes		5	10	Theory
M.12	312	**Bikes for commuting vs. bikes for recreation**		**13**	**28**	**Theory**
		"Bitten by the bug"		2	8	Memo

ID	Page	Memo	Network Diagram	Grounded	Density	Type
M.13	314	**Blocked discontinuance**		**2**	**6**	**Theory**
M.14	314	**Bus regret and bus karma**		**3**	**7**	**Theory**
M.15	314	**Buyer's remorse**		**5**	**9**	**Theory**
		Car sharing: how many cars?		4	4	Memo
		CarShare		1	1	Memo
M.16	315	**Changing your mind**	N.3, N.4, N.7	**4**	**9**	**Theory**
		Chopper Bikes		1	8	Memo
M.17	316	**Clinchers**	N.2	**4**	**11**	**Theory**
M.18	318	**Coadoption?**	N.4, N.5	**5**	**12**	**Theory**
M.19	319	**Collapsing decisions**	N.5, N.12	**2**	**11**	**Theory**
M.20	319	**Collective adoption and the origins of desire**	N.6, N.11	**0**	**4**	**Theory**
		Cross-town TriMet service		2	2	Memo
		"...Cursing at God, saying 'Give me more!' Can you give me more!'"		1	5	Memo
M.21	320	**Deal-breakers**		**5**	**14**	**Modeling**
		Dedicated bicycle facilities		10	11	Memo
M.22	321	**Design-time vs. run-time and structured vs. anarchic perspectives**	N.11, N.12	**0**	**3**	**Modeling**
M.23	321	**Discounting**	N.7	**2**	**5**	**Memo**
		Does driving desensitize risk?		1	1	Memo
		Dominance structuring: Convenience vs Cost		1	4	Memo
M.24	322	**E-mail as a memory supplement**		**2**	**4**	**Theory**
M.25	322	**Emic and Etic**		**1**	**7**	**Theory**
		Everyday Phenomenology		0	6	Methodology
M.26	324	**Exposure as an interrupt**	N.3	**1**	**6**	**Theory**
		Familiarity breeds contempt?		1	4	Theory
		Fear of the unknown		4	7	Memo
		Flexcar followup with #8		2	2	Memo
M.27	324	**Flexcar stress**		**14**	**15**	**Theory**
		"Fixies"		5	7	Commentary
		"Follow your own damn bliss"		10	16	Memo
M.28	324	**Forced adoption**		**0**	**2**	**Memo**
M.29	325	**From the inert set to the selection set**	N.1, N.9, N.12	**9**	**15**	**Theory**
M.30	326	**From the selection set to the inept set**	N.8, N.9, N.10, N.12	**4**	**7**	**Theory**
M.31	327	**From the selection set to the inert set**	N.8, N.9, N.10, N.12	**13**	**16**	**Theory**
M.32	327	**Functional needs vs. self-image needs**	N.2, N.8, N.10, N.11	**2**	**7**	**Theory**
M.33	327	**Functional needs vs. social needs**	N.8, N.10, N.11	**2**	**13**	**Theory**
		Gresham: car pool flexibility		3	5	Memo
		Gresham: TriMet Passport program		1	1	Memo
M.34	328	**Grounded Agent Modeling**		**0**	**2**	**Modeling**
		Hybrids vs. public transit		1	1	Memo
		Illusion of control		2	7	Memo
		"I can't lose."		1	4	Memo
		"I didn't have all my transportation issues sorted out"		3	5	Memo
M.35	330	**"I discovered that I didn't really mind"**		**2**	**10**	**Theory**
M.36	330	**"I just acted on the options that I knew I had."**	N.7	**2**	**5**	**Commentary**
		In between passive and active		3	5	Commentary
		Informant sampling		1	1	Methodology
M.37	331	**Intentionality**		**0**	**4**	**Theory**
		Interest "expiration date?"		1	4	Memo

ID	Page	Memo	Network Diagram	Grounded	Density	Type
M.38	333	**In vivo idioms**		**1**	**1**	**Memo**
		Irreversible decisions		4	9	Memo
M.39	334	**Is regret the inverse of dominance structuring?**	N.7	**6**	**11**	**Theory**
M.40	334	**"It was almost like they had a curfew"**		**2**	**6**	**Theory**
		"It was heaven...and it was damned!"		2	3	Memo
		"Jonny Appleseed"		7	7	Methodology
M.41	335	**Latent needs**		**1**	**2**	**Modeling**
M.42	335	**Learning and unlearning**	N.2, N.11, N.12	**0**	**3**	**Theory**
		Making a virtue out of a necessity		4	5	Memo
M.43	335	**Making the best use of your time**	N.3, N.6	**26**	**32**	**Theory**
M.44	337	**Microcommunities**		**19**	**26**	**Theory**
		Microcommunity spillover from bus to MAX		1	2	Theory
M.45	337	**Modeling desires**	N.11	**0**	**10**	**Modeling**
M.46	344	**Modeling mixed transit modes**	N.12	**2**	**14**	**Modeling**
M.47	345	**Needs vs. advantages**		**2**	**4**	**Theory**
M.48	346	**"No brainer" decisions**	N.2, N.5	**6**	**14**	**Theory**
M.49	346	**Norm theory and framing**	N.1, N.2, N.12	**1**	**4**	**Theory**
M.50	347	**Not on the radar**	N.1, N.2	**9**	**23**	**Theory**
		Observability		1	1	Theory
		One-upsmanship		3	10	Theory
		Park and Ride		1	1	Memo
		Paying your dues		1	7	Theory
M.51	348	**Perks**	N.2, N.3	**9**	**15**	**Theory**
		"Pretty ridiculous things"		1	5	Memo
M.52	349	**Primary needs, perks, and clinchers**	N.2	**1**	**8**	**Theory**
M.53	349	**Primary/perk vs. functional/social dimensions**		**0**	**8**	**Theory**
M.54	349	**Procrastination**	N.2, N.3, N.12	**16**	**28**	**Theory**
M.55	354	**Prompting event**		**5**	**9**	**Theory**
		Recall time		1	2	Memo
		Resistance to options		1	8	Theory
		Returning the TriMet annual pass		3	3	Commentary
		Satisficing for a necessary evil		2	7	Memo
M.56	354	**Selection process bias**	N.12	**1**	**5**	**Modeling**
		Short hops and long hauls		3	5	Memo
M.57	355	**Sleep on it**	N.3, N.5, N.6	**1**	**6**	**Memo**
		Slug Velo		1	3	Commentary
		Soaking wet		5	5	Memo
		Social loafing		1	3	Memo
M.58	355	**Stretching and cocooning**	N.1, N.3, N.6, N.10, N.11	**4**	**10**	**Memo**
M.59	356	**Successful advocacy and opinion leadership**		**5**	**9**	**Theory**
M.60	356	**Technology-centered identity**		**8**	**32**	**Theory**
		Technology clusters: Atomic time		1	1	Memo
		Technology clusters: Cell phone		6	6	Theory
		Technology clusters: Web		1	1	Memo
M.61	358	**Technology cults**		**2**	**8**	**Theory**
M.62	358	**Temors and Momors**	N.11	**0**	**5**	**Modeling**
M.63	362	**The "Ah-ha!" experience**		**1**	**11**	**Theory**
M.64	362	**The framing, adoption, and selection processes**	N.12	**0**	**4**	**Theory**
M.65	363	**The incommensurability of regret**		**1**	**3**	**Memo**

ID	Page	Memo	Network Diagram	Grounded	Density	Type
M.66	363	**The Morning Debate**	N.5, N.6	**0**	**2**	**Memo**
		The Sounder		3	4	Commentary
M.67	364	**"This idea has changed my life"**		**3**	**7**	**Theory**
		Time premium		0	5	Theory
M.68	365	**Timeouts vs. counts**	N.3, N.12	**3**	**10**	**Modeling**
		"Transit geeks"		9	9	Commentary
		Trying to take advantage of a perk		2	7	Memo
M.69	366	**TTM: The Hummer and the Bicycle**		**3**	**9**	**Theory**
M.70	366	**Using behavioral traps to overcome procrastination**	N.3, N.6, N.7	**9**	**17**	**Theory**
M.71	367	**Value-centered adoption**		**4**	**11**	**Theory**
		Voluntary simplicity		4	4	Commentary
		Weak ties on the bus		2	3	Memo
		Wilsonville: car pool flexibility		1	3	Memo
M.72	367	**Wilsonville: forced rejection**		**3**	**7**	**Memo**
		Zoobombers		1	4	Commentary

M.1. Adoption as an equilibrium state

[07/06/06] *Once decisions are collapsed and a new status quo emerges, decision makers seem reluctant to revisit them.* Samuelson and Zeckhauser (1988) [cited in Baron pg. 291] looked at health care plans and found that employees tend to stick with the status quo each year, even though they might choose something else if they were choosing for the first time. This might also explain why people tend to start the search process over again from scratch when they learn that a previously screened alternative is not available (Potter and Beach 1994).

This says something about why adoption is an equilibrium state. The Certainty Effect (Tversky and Kahneman, 1981) and pseudocertainty (Slovic, Fischhoff and Lichenstein 1982) suggest that people want to avoid spending extended periods of time in decision making chores. They have several strategies for escaping the discomfort of decision making, such as satisficing (Simon) or social loafing (Plous pg. 192-4). I suspect that different people learn different strategies for cutting short the decision making process, akin to how oyster catchers learn different strategies for opening oysters.

[10/09/06] In (26:30) I managed to catch #14 in an early stage of decision making:

B: Have you ever thought about just getting rid of your car?

#14. *I'm not there yet...*I'm not there yet. On the weekends I do things, and some things at night, where I really feel like I'd be safer in a car. Meeting friends for movies, or dinner, or something. Yeah.

She doesn't say "I thought of that, but decided not to." Nor does she state that she's definitely planning to get rid of her car. Instead, she paints her mental state in terms which suggest some kind of inner dialogue is taking place. It's as if some part of her self was trying to work up the nerve to take some difficult path. She's currently in an equilibrium state, and her words suggest she's not quite satisfied with the status quo, but she doesn't quite have the necessary oomph or stimulus yet to support a change to some other state.

This in interesting in light of the Mind and Brain book, which argues that we don't have just one center in our brains which decides what to do -- we have many. Our narrative self maintains a running dialogue of why we do what we do -- sort of the mind's PR agent.

M.2. Adoption as puzzle-solving

[03/01/06] #3 really went the extra mile to try and make this work, juggling needs, reconciling conflicting needs, trying to accommodate the innovation. There's a aspect of decision making that's like trying to solve one of those puzzles that involves getting the bead to roll around into the little hole. Stable equilibrium?

[07/11/06] #5 also seems to have taken a decision as a kind of stable equilibrium: taking the train would shorten the commute, the permit cost was reasonable, and he believed it would encourage him not to drive (to take advantage of it.) Kind of a strategy for using the potential for regret (if he didn't take advantage of the pass) as a way of ensuring that he would keep at it. Of course, it didn't quite work out that way for him...

[08/23/06] #8 liked my BB-in-the-hole metaphor for her dilemma in trying to figure out how she was going to manage child care issues and reconcile that with bus use (23:45).

[10/05/06] An alternative metaphor might be to think of decision making as akin to weaving or knitting. We learn certain basic decision "stitches" or "knots" and reuse these over and over again as circumstances arise (although this would tend to point back in the direction of decision heuristics, which it seems to me has been a bit of a theoretical dead-end.)

[04/08/07] I heard this one again the other day -- the idea that people learn and reuse particular decision making strategies throughout their lives is beginning to gain currency in the psychology literature. This reminds me of the oyster catcher birds learning particular predation strategies from their parents.

M.3. Adoption vs. retention

[4/17/06] In looking at #4's transcript, the thought occurs to me that the reasons for adoption may be quite different from the reasons for retention. #4 adopted because it was fun, because it was a social outlet, and because he harbored positive feelings about cycling since he was a youth. He continued cycling because it was fun, yet he also began to recognize that health considerations were a good reason to continue cycling. This dynamic might be expressed in terms of dominance structuring -- finding reasons to bolster the earlier decision -- but I don't think that quite captures what I'm seeing in this transcript. What it looks more like is that he began to find legitimate advantages to retaining the innovation which were not things he originally considered.

M.4. Autogenesis

[11/25/06] My entries today on run-time vs. design-time structure, the structured vs. anarchic perspectives, and temes and memes is recalling to my mind the earlier work I did with autogenesis during my dissertation proposal. Some relevant quotes:

> "A great deal of research on self-organizing involves developing equations, or other forms of rules, that can be used to graphically portray the unfolding of emergent structure over time. To analyze the relationship between structure and process, researchers have increasingly turned to the computer as a tool for capturing synamic systems (Friedhoff, 1989). Computer simulations make it possible to produce both direct and indirect visual representations of self-organizing systems as they evolve over time (Abraham & Shaw, 1987; Gleick, 1987; Lorenz, 1987)." (Drazin & Sandelands, 1992, pg. 235)
>
> "One of the consequences of force fitting process into variance theory is the creation of language that gives the illusion of process when a process has in fact not been described. It seems that the researcher who tried to develop a process theory, but works within a variance framework, always runs into a logical bind with the only escape being to use process-like

achievement verbs, such as 'environmental selection' or 'strategic choice'. These verbs become part of the metatheoretical background of an argument for process but are never actually described or tested. Theories which use words like these tell stories which sound process-like but which lack genuine process content." (Drazin & Sandelands, 1992, pg. 245)

"Autogenesis is the idea that organization can be explained by observation and categorization of the interactions of independent actors whose behavior is governed by a system of recursively applied rules. Autogenesis is pre-eminently a process-oriented perspective because it focuses on explaining how organization emerges, rather than why it emerges (Mohr, 1982)." (Drazin & Sandelands, 1992, pg. 236)

The reference to recursion is particularly relevant in terms of the collapsing/exploding/contextualizing operations I'm thinking of including in the external interface as a way of communicating with my "ontology server".

"The autogenesis of social organization can be analyzed in terms of three different types of structure:

(1) deep structure, which consists of rules that generate and govern individual behavior and interactions,

(2) elemental structure, consisting of interactions among individual actors, and

(3) observed structure, comprised of the categories and terms that apply to the perceptions of social interaction as collectives by observers."

Level	Definition	Key Properties
Deep Structure	Tacit rules that govern actors in their actions and interactions	Virtual and unobserved, Generative – The dynamic recursive function that creates elemental and observed structures.
Elemental Structure	States of actors, Interactions among actors.	Observed in time and space, consists of micro-level structure
Observed Structure	Social facts constituted by interactions among social actors.	Observed in time and space, consists of macro-level structure.

It's a little less clear at first how this maps onto the run-time vs. design-time distinction; all three of these seem to correspond to instantiated run-time structures. The closest thing to a static design-time structure would seem to be deep structure; perhaps "design-time" is just a convenient reference point, a way of treating what is really a dynamic process as a static process because unconstrained dynamism makes explanation, understanding, and prediction impossible. Certainly elemental structure would seem to correspond to ontological instantiations within agents (systems of personal meaning), and observed structures would seem to correspond to innovations and ideas (systems of shared meaning). Deep structure would then correspond to psychological and neurological forces which give rise to elemental structures. Deep structure may be dynamic, but any change in these structures would tend to take place over many generations through evolutionary forces. In humans, second-order emergence would tend to accelerate these processes and make it possible for deep structure to be modified, at least within individuals, through mechanisms such as learning and education. Here's the tie to organizational learning...

"[Deep structure] rules play a central role in the model because they generate the observable patterns of interaction over time that make up the organizing process. Dynamic processes can be summarized by generative rules and these rules are an efficient description of that process (Goffman,

1967; Chomsky, 1972; Gleick, 1987)." (Drazin & Sandelands, 1992, pg. 237)

"Different organizing processes are likely to be governed by different rules...At the same time, there are likely to be certain rules which generalize across situations, if only because human behavior is not infinitely variable, but retains a distinctively human character across situations." (Drazin & Sandelands, 1992, pg. 238)

"Researchers have little choice but to observe patterns of overt behavior and work backward to infer rules that could have produced them - a procedure that is bound to produce multiple and competing conceptions of rules." (Drazin & Sandelands, 1992, pg. 238)

"There is a paradoxical aspect to rules. On one hand they are produced by social action - their institutional form being objectivated human activity. On the other hand, they are experienced as something tangible and often felt as constraints. This experienced quality gives rules their deep structural character." (Drazin & Sandelands, 1992, pg. 239)

"[Elemental structure] is the kind of social structure with which we are natively most familiar, which appeals most directly to our senses. Because we are especially aware of individuals in our environment we tend to regard social structure at this level as uniquely objective and concrete - and more so than structure at the level of rules, or at the level of observed structure." (Drazin & Sandelands, 1992, pg. 240)

"Observed structure includes entities such as groups, teams, coalitions, business units, departments, and whole organizations. ***Observed structure also includes various relations which may be postulated between entities - such as causality, constraint, intention, or mimesis***." (Drazin & Sandelands, 1992, pg. 240)

I particularly like how Drazin and Sandelands note that observed structure is not an element of autogenetic reasoning. That certainly tracks with the way I'm looking at ideas and innovations, that they are not an element of reasoning in my theoretical framework. Instead, they are emergent, run-time observed structures. Of course, the name "observed structures" is problematic, since to my mind ideas and innovations cannot be observed directly. (What can? Evidently only elemental structures can be observed directly by us -- yet perversely, elemental structures cannot be shared with others.) The implication is that we can individually observe the world, but that our ability to share these observations is inherently imperfect.)

"One implication of the role of the observer in the conception of structure is that familiar terms, such as organization and environment (along with a host of other terms), become more problematic. We see that they are not immutable things, but partly artificial constructs invoked by the observer to bring order and sense to a confusing world." (Drazin & Sandelands, 1992, pg. 241)

"Our understanding of organizations depends on our position as observers of unfolding processes. Taking an autogenetic perspective encourages us to look at different levels of structure and process and to discern connections between them. By conceiving of organizational theory this way it is possible to explore alternative ways of seeing and gain valuable insights about the dynamics of organizing." (Drazin & Sandelands, 1992, pg. 242)

"Deep structure offers insights into elemental structure because elemental structure is what one sees when rules operate. Similarly elemental structure offers insights into rules because rules are redescriptions of elemental structure at a deeper level. Elemental structure illuminates observed structure because observed structure is what is discerned amidst the bustle of elemental structure. Observed structure reflects back upon and illuminates elemental structure when observed structures are analyzed into constitutent elements." (Drazin & Sandelands, 1992, pg. 242-243)

"By making alternative views of structure explicit, the autogenetic perspective avoids the nettlesome problems of reductionism and reification that plague organization theory." (Drazin & Sandelands, 1992, pg. 243)

[02/25/07] See today's entry in the "intentionality" memo.

M.5. Automobiles as addictions/attachments

[7/12/06] This quote, along with other source materials ("My name is Randy, and I'm addicted to oil" - Willamette Week, February 22, 2006; subscription form to Car Busters magazine) is an interesting tie-in to the TTM questionnaire.

However, I am skeptical that the addiction metaphor applies to automobiles, as the problems with the TTM survey tend to bring out. Most people are living in places where it just isn't practical to stop using cars altogether, and indeed our technological civilization could not sustain itself without them in some form. But it is an interesting statement from the standpoint of identity construction.

[07/23/06] The process of reducing automobile use is indicative of a style of decision applicable to lifestyle changes in keeping with Beech and Lipshitz (1996) - the image of the ideal self, countered by powerful constraints imposed by past 'decisions' (either implicit or explicit). Rather than sunk costs, automobiles serve as golden handcuffs. Technologies (cars, in this case) ensnare as well as reward. It is in some sense akin to addiction, or to the Buddhist concept of 'attachment' -- but there are limits to the addition metaphor. Cf. quote from Gigerenzer (2001 pg. 40): "Christian ideal of omniscience or Laplacian superintelligence"

This class of decisions characteristically have a high degree of involvement, perhaps extending to a new conception of the self as a result of having made a change in a direction consistent with the higher conception of the self, and at the cost of considerable personal sacrifice. This is a type of decision with deep philosophical, psychological, and evolutionary roots.

[07/26/06] #10 uses the addiction metaphor too: "Cars as they exist now are almost like a cancer or plague on our society...it's due to drug-like forces, people being addicted because of sociological business forces." But then he goes on to ask the rhetorical question "But what can you do about cancer on society?"

[07/27/06] Here it is again, in #4's observation that "...with the fixed gear there's sort of an anti-car elements built into it, and also sort of a nonconformist element built in." Although he goes on to say that this isn't the same as a green self-image; within his group of friends, the environmental argument is taken as a kind of given. *Green is different than nonconformist.*

[10/13/06] I think #18 may have been the only informant in PP+ who actually referenced peak oil...and yet she's also probably the heaviest car user in the bunch. Maybe that's not a coincidence -- she could be working through some guilt issues (I notice she's also Catholic, for what that's worth):

B: So, would it be fair to say that your car is sort of a necessary evil? Would you go that far?

#18: No. I don't think a car is necessary. I think a car is a luxury that I indulge in too much, perhaps.

B: And you continue using it because the alternatives have problems?

#18: I don't like them so much, but I still would say that I have resigned myself to needing to [make greater use of them.] It's like...I've got to quit smoking. It's the same thing, like 'I gotta.' And eventually I will.

M.6. Being a grownup

[5/15/06] Malcolm Knowles discusses "The Learner's Self-Concept: Adults have a self-concept of being responsible for their own decisions, their own lives. Once they have arrived at

that self-concept, they develop a deep psychological need to be seen by others and treated by others as being capable of self-direction. Most adults resent situations where others are imposing their wills upon them..." from "Technology-based training and adult learning theory", a paper submitted for Charles Weber's knowledge management class in Winter 2006. There are three Knowles references in this paper, I'm not sure which one it's referring to:

- Knowles, M.S. "The Modern Practice of Adult Education: Andragogy versus Pedagogy." New York: Association Press, 1970.
- Knowles, M.S. "Andragogy in Action." San Francisco: Jossey-Bass, 1984.
- Knowles, Hold, Swanson: The Adult Learner (2005)

[07/19/06] Or, as #10 puts it here, "having a life as a normally functioning human being."

M.7. Being a kid

[07/18/06] Something that strikes me about #5, #10, and #4 is that they all trace the formation of their bicycling identity to positive experiences as children. On one level this shouldn't be surprising -- that's when most people learn to ride bikes -- but I think there's more to it than just that. Learning to ride a bike is an important rite of passage for children. Along with toilet training, telling time, and learning to use the telephone, *learning to ride a bike ranks among the most significant tool-related accomplishments of childhood.*

Learning to ride a bike is also important in a second sense: it opens up a wider world for exploration and an *important step away from dependency on one's parents for transit needs*. Once I'd learned to ride a bike I didn't have to be restricted to my own neighborhood; I could wander and explore, and dream of getting on my bike and riding away from home without stopping. It's a powerful association, and I doubt many people ever forget owning their first bike.

When teenagers come of age to drive a car they may put away their bikes for a time, but nobody is too old to ride a bike. If the infrastructure is available it can be a very pleasant way to get around, which might explain why so many people could entertain the idea of riding a bike more often if they only felt it were a viable option. *The BTA says that 60% of the population of Portland is not currently cycling, but is interested* (source: Bike Boulevards Campaign flyer; I think this figure comes from Mia Burk's talk at the Bike Summit.)

Perhaps there's an opportunity here to take old bikes and refit them to be "checked out" library-fashion for people who are thinking of buying, but want to be convinced that biking is possible and safe before laying down the bucks...

M.8. Being a professional

[07/31/06] In (17:26) #4 touches on bikes and professionalism:

B: Were bicycles even on your radar at that point?

#4: You know, I didn't consider it at the time. I'm not entirely sure why I didn't. I guess maybe to a degree there's sort of a professionalism to using either a car or a bus, that a bike doesn't necessarily immediately lend itself to that. It doesn't make sense for me to say now, but maybe at the time that was more of my thinking.

These comments are supported by (43:4):

> "Some lawyers don't want to visit clients in a car like this, but I don't care, because this idea has changed my life," said Polfliet, who uses Greenwheels instead of owning a private car.
>
> (This comment is from Amsterdam.)

And (57:1):

"Cyclists used to be seen as blue collar workers who drive their bikes to work to save bus fare. But today you see executives, government workers, lawyers, students -- everyone is riding."

(This comment is from Santiago, Chile -- one of the most socially conservative societies in South America. So much for the idea that biking is the sole province of "blue" cultures.)

M.9. Bicycle adoption as a series of challenges

[04/20/06] From an April 20th e-mail to Dan Zalkow and Eben Saling:

> Although I only began my field research in January and my findings are still very tentative, one of the things I'm starting to hear from multiple informants is that Flexcar may be more useful to bicycle commuters than TriMet users. The reason has to do with the nature of how the bicycle decision unfolds. *Generally speaking, bicycle commuters seem to begin gradually, using their bikes only to make limited trips in good weather. There are a number of concerns that bike commuters harbor at this early stage (safety, security, weather) and it takes them a little while to get a handle on how to solve this series of challenges. A couple of factors seem to be important in encouraging them to 'stretch' their bicycling commuting practices 1) the availability of role models -- near-peers who are visibly successful as bicycle commuters. 2) the availability of dedicated support to help surmount some of the practical barriers to bicycle commuting. This includes striped bicycle lanes, but it also extends to things like shopping, which is hard to do on a bike.*

If I'm correct, then one promising strategy for increasing bicycle commuting to the PSU campus would be to put together some sort of comprehensive package for beginning bicycle commuters. For a nominal fee (say, $20-$40/year) this might include a Bike There! map; access to a secure bicycle storage area somewhere on the PSU campus; access to the shower facilities at Stott and a locker for street clothes; a list of dry cleaners around the campus who could launder work clothes without the need to haul them home; membership in the PSU Bicycle Coop, which has repair facilities; a free training class in bicycle maintenance conducted by someone at the Coop; and an annual Flexcar membership. I don't think it would be necessary for the university to pony up the 4 hours of free Flexcar use for bicyclists, because their usage pattern would likely be different and centered more on off-campus use. The goal here would be to encourage people to ride their bikes everywhere, including the PSU campus. Providing Flexcar would help alleviate the concern that bicyclists couldn't go shopping for groceries, or might find themselves needing to get to some distant location quickly. *I believe the key to getting people to bike to campus is to encourage them to bike all over the place, including the PSU campus (in management terms, "growing the market" for bicycle commuting generally, which would naturally increase the number of people riding bikes to the campus.)*

[07/25/06] *Summary of factors which have emerged so far in encouraging people to commute by bike:*

- *The availability of role models.*
- *The availability of dedicated en-route or end-trip bicycle facilities (bike lanes or boulevards; shower facilities)*
- *A prior history of favorable bicycle use.*
- *Currently experiencing some feelings of regret or conflict about one's existing transportation mode. (Car, bus, etc.)*
- *The ability to visualize an image of yourself biking to work, and what that might feel like. (Getting some exercise, reducing pollution, saving money, becoming part of something cool, having fun, feeling good about yourself.)*

- *Having a practical plan for getting there by bike (or at least the ability to try bike commuting on a limited basis. Could a "bike library" help here by reducing the cost of experimentation? Having the bike for a finite period of time might help people get over the procrastination hump.)*

It is a little less clear what role a ***prompting event*** would play. Perhaps the importance of a prompting event at this stage is to get people to pay attention and overcome selective exposure -- forcing something onto the radar, as it were.

[07/26/06] Add to that list the additional factor of *discovering that the actual challenges of bike commuting aren't as bad as the anticipation of those difficulties*, as #10 related in (14:99).

[07/31/06] In (17:74) #4 discusses why he purchased PP+ at first instead of biking to PSU -- the *first obstacle, he didn't have a "setup"* (i.e., a commuter bike.)

[08/01/06] Here's another challenge discussed by #4, from (17:81): *the ability to estimate how long it will take to get from point A to point B*, factoring in not only the time in the schedule (if one exists) but also real-world experience: unplanned delays, walking time, locking up the bike, etc. That requires a base of prior experience to work from. The absence of such a base of experience leads to unknown risk.

[02/25/07] #36 says something interesting from (26:00-29:30):

> Stubbornness [carried me through it], I suppose. I just kept saying to myself, 'Why can't you figure this out?' I'm 51, I really want exercise, and I kept feeling 'I've got to figure this out!' All of these other things that I kept trying to get an exercise routine, it just wasn't working. I don't know...I guess I just said 'I can do this!' It was scary to me, you feel so vulnerable on a bike as you know. There are a lot of unaware people; they're not bad people, they're just clueless. 'Hello! I'm right here!' [...] *I was just keeping my fingers crossed.*

She is in a situation where she knows there are problems with the status quo -- she doesn't know how to fix a flat -- yet it doesn't seem like a realistic plan to learn how to fix one, given that she doesn't carry the equipment with her or get enough practice to remember how to do it when it occurs. Thus, *she is trapped in an imperfect status quo without any other plan than* ***"keeping my fingers crossed."***

[04/20/07] There's something kind of ironic when #22 says that people get kudos from their coworkers for biking thru the winter. The implication is that people are impressed by your willpower; and yet my research suggests that willpower is actually a weak motivator for most people. Those people who continued biking thru the winter often did so because there was some strong hedonic motivation at the back of their decision. And yet, somehow, we don't find that quite as admirable as someone who continues through sheer force of will...

[04/25/07] Summary of factors which have emerged thus far in determining whether people will continue to commute by bike:

- Road hazards, especially in the bike lanes.
- Potholes
- Wet leaves
- Broken glass
- Rain.
    - Variety of responses to rain gear; it's an open question whether it's really worth it (a wash). It's a question of whether it's worth the extra time to get wet inside the gear from sweat than getting wet outside the gear from rain. This is related to temperature regulation.
- Dark.
    - Seeing the road.
    - Being seen by cars.
    - Seasonal affective disorder -- saps energy and willingness to ride during December?

- Cold
  - Regulating body temperature -- see rain. Very hard to keep a consistent comfortable temperature.
  - Black ice and frost. Very dangerous -- this is one of the show-stoppers.
- Wind and fog.
  - Dense fog is another very dangerous biking condition. Fortunately we don't get valley fog much in Portland.
  - Wind is a royal pain, but it seems to be limited to certain times and places. It seems to be more common down by the river.
- Hygiene
  - I was surprised that more people didn't complain about the lack of end-of-trip facilities like showers. People seem fairly capable of adapting to this.
- Time utilization
  - Time required to find your gear
  - Time required to put the gear on
  - Time required to pull the gear off
  - Time required to store the gear
  - Extra -- the 'hassle factor' of putting gear on and taking it off (booties too snug for your shoes, flaps that won't stay flapped, getting overheated while waiting to walk out the door, etc.)
- Maintenance
  - If you do it right, the bike needs regular cleaning, oiling the chain, etc. because water and road grime are bad for a bike. However, a lot of people simply ignored this issue.
  - Exception: brakes require more attention in winter. This can't be ignored.
  - Maybe more flats due to more crap accumulating by the side of the road.

Seasonal affective disorder is particularly important. According to my theory, affect drives technology adoption and selection. Therefore, anything that suppresses affect is likely to suppress adoption -- and there is evidence in the winter bikes case that seasonal affective disorder did indeed cause people not to bike in the darkest part of December.

M.10. Bike commuting perceptions – novice vs. experienced

[07/12/06] Based on anecdotal experience, plus the discussion at the Bike Summit on June 12, there seems to be a pretty sharp divide as to how commuting challenges are perceived between novice and experienced riders. This is also borne out in the Oregonian article from June 16 about bike boulevards.

[07/24/06] These differences in perception are hinting something important about changes in personal value system and self-image that occurs as a result of adoption.

[08/01/06] The shift from novice to experienced biker may involve gestalts of its own, as #4 alludes to in (17:85). Perhaps these occur as the accumulation of experience causes the informant to discard previous unknown risks (but what happens to dread risks? Are these subject to discounting per Montgomery's dominance structuring theory?)

[08/09/06] Jason's first ride downtown points up that access to experienced adopters is an important factor in overcoming barriers; so is safety in numbers.

[08/23/06] I think this issue is also important by its relative absence from the public transit modes; there doesn't seem to be a major difference in perception there. Ditto for Flexcar, and indeed for the annual transit pass itself. Perhaps this speaks to the relatively more complex nature of the bike commuting decision (Svenson's type 4 vs. type 3 or 2.)

M.11. Bike culture vs. mass transit (non)culture?

[07/06/06] Why does bicycling support such a rich subculture in Portland, while mass transit lacks any distinctive cultural features? Where does Flexcar fit into this? (Flexcar seems to share certain 'technology cult' features with TiVo)

[09/21/06] *This topic is emerging as an excellent theme for cross-case comparison.* After interviewing half the bike cohort, I am struck by the differences in how people approach bikes vs. mass transit, and in particular the bus. Many (but not all -- the exception being #36) of the bike informants have described their involvement with bikes as stemming from deep self-image issues.

- For #20, bikes are about rediscovering her own needs and getting back in touch with her former interests after the graduation of her daughter.
- For #25, bikes have awakened a new interest (hobby?), and he has immersed himself in learning more about the mechanics and history of the bicycle.
- For #21, bikes have been instrumental to her recovery from a serious, dehabilitating ear tumor; they represent independence of mobility as well as a comforting and nurturing tie to fond childhood memories.
- For #27, bikes are part of his construction of a new life for himself after a period of economic hardship. He has immersed himself into the online bike community and formed a new, heightened awareness of bike issues. Whereas his previous level of political consciousness was fairly low, he now sees himself as part of a larger movement.
- #36 provides a contrasting case. For her, the issue at age 51 is principally finding the time in her day to get some exercise, and bikes are a means toward that end. Economic considerations play little role. She is ambivalent about continuing, and it is an open question as to whether she will continue to ride as the days turn wet, cold, and dark.

By contrast, buses do not seem to spark much interest in the way of community formation. This week I discussed this issue with Jason, pondering why people don't seem to form strong social attachments on the bus. He said that many times he didn't want to have conversations on the bus -- he wanted "private time" to wake up, and encouraging social bonds on the bus would be counterproductive as it would tend to create unwanted social obligations which would be inescapable due to the restricted nature of the bus (concentrating trips in time and space.) *This really reminded me of what #3 said about car pools, and the social tensions they created.* From (5:162):

#3: I did develop some sense of community with my carpool mates, but because one person's always driving, you're not having quite as much interaction. And *I think because there's this inborn tension from relying on each other so much. You get a little friction all the time.*

Jason said that some people he observed on the bus just can't seem to shut up, and the last thing he wanted to do was to fall prey to an "attention vampire."

Bikes would seem to offer the freedom to form communities and to choose social connections, without requiring them or constraining them in undesirable ways. Buses complicate the picture as they force social interaction, rather than permit it to freely occur or not to occur, as desired. *People in communities (American ones, at least) seem to desire the freedom to come and go, to decide upon their own level of participation. Bikes allow that; the bus does not. People may be reluctant to form microcommunities on the bus because they run the risk of creating a social obligation that may be difficult to escape from should the relationship turn undesirable. Bikes do not have that problem.*

[06/01/07] See today's entry in "technology-centered identity".

[06/26/07] Today I met with Jeff Mapes, who is on leave from the Oregonian to write a book on Portland's bicycling community. He made an interesting remark, saying that ***the bus is sometimes called the 'loser cruiser' in Los Angeles, meaning that in places where the bus service is known to be lousy, and you ride it anyway, they you are a loser -- because riding the bus is seen as an act of desperation.*** It becomes difficult to construct a plausible justification for riding the bus on any other basis than desperation; claiming that you're riding the bus out of concern for the environment just isn't credible. On the other hand, the social stigma of using transit lessens as the quality of service improves -- thus, there's a vicious cycle in operation here.

Does this apply more generally? Are bikes accorded low status in certain locales where the level of service is very low?

#23: Even my friends would think it was idiotic to ride your bike in West Virginia. People on the road probably wouldn't give [a bike] any more thought than a squirrel crossing the road. I get more of a sense that there may be some socioeconomic or political statements by [cyclists] getting hit or harassed in Portland than I ever would in West Virginia; it was just downright not safe. People drove fast; they drove aggressively; we didn't have freeways, so it's all winding country roads. People wouldn't even see you, any more than they would see a squirrel or a possum. They didn't even have an interest in seeing them. I don't think they were paying attention; I don't think it was a political issue. [...] There was no encouragement and no bike community; literally, nobody rode their bicycles. You just didn't. If you ever saw somebody riding their bicycle, you knew they lost their license for DUI and that was the only reason they were riding their bicycle!

and:

#10: I had been riding a bike in Memphis and had things thrown at me. I'd been hit a couple of times, and one of the times the person hit me with their rear-view mirror, and then pulled over to the side of the road, and then proceeded once I'd stood up - I mean, it didn't toss me badly, but it, you know, shook me off my bike. I stood up next to my bike, and they had stopped and pulled up, and as soon as I stood up and started walking toward the truck, they sped off. And this was on a highway road out in the middle of nowhere, near Memphis. [...] In Memphis, people would swerve at you just because...*it's just Memphis.* They're just very hostile, and you're a target if you're on a bike, you know? It's just a hostile environment. It's just...Memphis.

M.12. Bikes for commuting vs. bikes for recreation

[7/11/06] Interesting that #5 says that recreational biking tends to facilitate social relationships, but commuter biking does not. Perhaps there's something fundamentally different in the needs which are met by these two modes of use, something which isn't captured in the notion of "mode choice".

[7/12/06] #5's statement about "I haven't typically met all that many people through [bicycle] commuting, because it tends to be a sort of solitary activity" (11:109) stands in contrast to the many friends he has met as a result of recreational riding (11:107). *What is different about bike commuting vs. bikes for recreation?*

- Recreation can be solitary, but its enjoyment is enhanced if done as part of a group.
- By contrast, commuting is easier to accomplish if done alone (cf. #3's remarks about carpooling, and the tension that results from having to coordinate one's commute with another person.)
- Commuting trips tend to be more frequent and shorter(?) and proceed from functional needs.

- Recreation trips tend to be less frequent, require planning, longer(?) and more leisurely, and proceed from socio-aesthetic needs (i.e., having fun). Fun is its own justification, although certainly exercise would apply in both cases.
- Recreational riding partners may be hard to find, thus creating the need for cycling clubs like the Portland Wheelmen. There seem to be few analogous organizations for bike commuting, although organizations like the BTA exists for lobbying purposes. This seems like a fundamentally different kind of need -- the BTA isn't primarily a social organization, even though social contacts do occur as a byproduct of its activities. By contrast, the Wheelmen is primarily a social organization.

Somehow this seems important to the question of the kinds of communities which are formed. Recreational biking facilitates social cliques, but does not necessarily facilitate an identity centered on bicycling. Commuter biking, by contrast, does not facilitate social cliques -- the interactions are too brief -- but does facilitate the formation of a technology-centered identity. That identity, in turn, stimulates social organization for the purpose of protecting and expanding the welfare of all group members (e.g., through lobbying.)

Thus, *two contrasting examples of how a technology can bring about social organization.* And perhaps this has something important to say about why recreational riders don't automatically become commuter riders and vice versa. The underlying needs are different. The primary needs addressed by commuter biking are functional; the primary needs met by recreational riding are social.

There may also be secondary factors involved, since not everyone wants to self-identify with bikes-as-a-lifestyle, even if they may be sympathetic to those goals (cf. Abbott's "The Chaos of Disciplines") Bike-centered identity projects an image to outsiders (cf. the

[07/24/06] I think this also relates to the category of "bike commuting as a series of challenges". Recreational riding often occurs within the context of organized group activities; there is often a cadre of experienced riders around so that many problems have already been anticipated and solved in advance. Commuting, by contrast, is by and large a solitary activity. *The bike commuter must encounter each issue as it arises and develop a solution* (either home-grown or by asking others). Over time this either thwarts further progress -- if the problem is intractable -- or else the commuter finally works out solutions to all the major problems. In this latter case *I hypothesize that this series of challenges acts as an initiation or rite of passage, leading to changes in personal self-image and values, and cementing the technology's place in one's life in a totally different way than recreational riding. ("Paying Your Dues")*

[07/26/06] As #10 demonstrates (14:107) this mental hurdle works both directions: he uses his bike to commute, but not to ride recreationally.

[08/01/06] This whole passage by #4 at quote (17:79) is very illuminating.

[10/09/06] In (26:30) and then again in (26:37), it seems clear that recreational and commuter biking is tapping a very different set of needs. #14's commuter biking, if she did it, would be primarily functional in nature. By contrast, her recreational biking is primarily social -- so she can ride around at Sauvie's Island with friends. Even her trips to the Farmer's Market seem motivated primarily for the enjoyment rather than the need to transport vegetables to/from the market; it simply provides a nice excuse for a bike trip. She details her thought process about commuter biking in (26:37).

[06/22/07] *It seems to me that this is getting at some kind of category error.* This has only become clear after talking to #36, who does not view her bicycle as a thing-for-transportation. To her, the bike is a thing-for-exercise; and similarly the recreational cyclists which #5 refers to view their bike as a think-for-sport. Thus, a conversation between a bike commuter and a sport biker may lead to frustration because they don't view these categories in the same way.

M.13. Blocked discontinuance

[3/14/06] I suppose blocking can occur any time the consumer decides to take action! I knew implementation could be blocked, and that adoption could be forced, but the idea that rejection could be blocked...but of course it makes sense, especially given the kind of heavy-penalty-for-discontinuance contracts that are being written these days...interesting tie here to Krackhardt's work in using network analysis to determine power relationships among monopolists and monopsonists.

M.14. Bus regret and bus karma

[07/25/06] I can relate to what #10 says here in (14:44). *Bus regret* is that feeling of 'Damn! I just missed the bus!' It is the opposite of *bus karma*, the feeling of satisfaction that comes from arriving at the bus stop just at the moment when the bus is pulling up so that you don't even have to run to catch it, and don't have to spend any time waiting for the bus either. As a bus rider I am conscious that bus remorse begins to build as I approach a bus stop at a blind corner when I can't see if the bus is close. It continues to build to a maximum when I'm close enough that if I run, I could catch it; but if I continue to walk, I'm going to miss it. It is caused by the suspense over whether I'm going to be there just in time, or whether I'm just going to miss it by a hair. When I arrive at the bus stop I can finally see how close the bus is; if I've just caught it, then I say to myself 'I've got good bus karma today!' and feel good. Otherwise I settle in to wait for the bus.

Bus regret stems from *approach-avoidance conflict*, which occurs when we approach (in space or time) an event which we associate with mixed feelings of reward and punishment (catching or missing the bus.) The opposition of bus regret and bus karma tends to confirm that some sort of inverse relationship exists between regret and dominance structuring.

Oddly enough, *I don't think bus regret is really about time utilization.* It's akin to beating the train across a railroad crossing, or a car just squeaking past a yellow light. It doesn't matter than much in most cases whether you arrive at your destination a minute or two earlier, especially if it occurs at some considerable personal risk. Time just doesn't enter into the decision frame; *it's purely a matter of whether the decision outcome falls into the domain of gains or losses.* Thus I don't think time utilization really has that much to do with it, or at best it's a percentage difference like psychological accounting. Prospect Theory (Tversky and Kahneman 1981) predicts this.

M.15. Buyer's remorse

[07/24/06] #10 says that he felt a mild amount of buyer's remorse after learning that he would be paying for two unused months on his transit pass. This *buyer's remorse seems to have undercut his ability to feel good about his purchase (i.e., undermined his attempt to construct a dominance structure -- confirming that regret and dominance structuring seems to be opposing forces.)* This corresponds to Schein's 'disconfirming the status quo', which (together with the availability of substitutes and the construction of a plan to turn the substitute into a viable option) led to the reversal of #10's decision and to see a refund on his pass.

Perhaps if there is no regret associated with an adoption decision, it is harder to reverse. This sounds similar to the 'happy end effect', the tendency to place greater emphasis on more recent positive effects than more distant negative ones. The Psy 510 notes go on to state that the positive value of an outcome can linger long after the cost has been forgotten, supporting the idea that *the ability to construct a dominance structure tends to 'freeze' a decision and make it harder to reverse.* Festinger's work on cognitive dissonance suggests that if this dominance structure is publicly articulated by the decision maker (e.g., by construction of a *technology-centered identity* and

formation of social links through membership in various affinity groups) then reversal will become even more difficult and adoption will further solidify.

Significantly, this is immaterial to whether all the original needs were being met. *Regret effectively involves the addition of new needs to the decision frame.* Had TriMet simply said the cost was X, and there been no discussion of whether the pass was prorated for the two months missed, #10 might not have framed the decision outcome in the domain of losses, and thus would have remained steadfast in his decision (perhaps even constructing a dominance structure in terms of enjoying riding the train, getting to read, etc.)

The fact that #10 had to hand them a check on the spot probably accentuated the buyer's remorse and threw it into sharper relief. (14:80)

[07/25/06] In quote (14:92) it appears that *#10's buyer's remorse intensified after he had the successful bike commuting experience* on the second or third day of his job. As soon as biking became a real option to him, his internal conflict and feelings of regret intensified. This is very interesting. It suggests that *regret over an evoked option plus the existence of a viable substitute is a powerful motivating force, and possibly the only thing standing in the way at that point is some sort of use block for the substitute.* I suppose part of the reason why his feelings of regret became so powerful is that he already intimated that money was very important to him, and that wasting money ("paying 23 bucks a month for a pass I'm not even going to use") was the source of this conflict.

M.16. Changing your mind

[7/10/06] Here #5 says there were two (actually three) important factors to his decision not to continue using the annual TriMet pass:

- Dissatisfaction with the status quo ("some little disillusionment with the train", principally regarding time utilization)
- Availability of a more attractive substitute ("bike commuting")
- A feasible means for getting there ("my success with bike commuting")

#5 emphasizes the latter as being more important than mere dissatisfaction with the train. After all, it is possible to commute by MAX, so the status quo does work; it just isn't optimal. Of course, this reminds me of Schein's typology of factors important to change. But it also raises questions about just what the "status quo" is. Is it a previously collapsed (solved) decision? And perhaps the hesitancy to revisit it is due to the trouble (read: cognitive effort involved) in reopening it? And the possible feelings of regret it might bring to the surface?

[07/11/06] #5 says he changed his mind within a very short space of time here. Sounds like a framing issue.

[07/19/06] #10 also changed his mind within a very short space of time -- a period of about five days. *Regret, the availability of a viable alternative, and the reversibility of the decision all seem to have played a crucial role.* But based on the experience of #5, it's not clear that reversibility played as important a role as the other two factors, if only because #10 simply would not have renewed his pass the following year. Later on, it clearly emerges that "my success with bike commuting" also played an important role for him as well -- thus, his experience in changing his mind closely parallels #5's, in that all three factors were involved:

- Regret about the status quo (the pass was expensive)
- Availability of a more attractive substitute (bike commuting)
- A feasibility means of getting there (successful bike commuting during that first 5-day period)

[07/21/06] This same pattern was confirmed again in today's decision to cancel a Flexcar reservation in favor of taking a taxi to the vet. Once again *regret, the availability of a viable alternative, and the reversibility were key factors.*

M.17. Clinchers

[07/05/06] From the Wikipedia entry on killer applications, retrieved July 5, 2006 from http://en.wikipedia.org/wiki/Killer_application:

> A killer application (commonly shortened to killer app) is a computer program that is so useful or desirable that people will buy a particular piece of computer hardware, gaming console, and/or an operating system simply to run that program. See the killer game entry for video-game related killer apps.
>
> **History**
>
> The first example of a killer application is generally agreed to be the VisiCalc spreadsheet on the Apple II platform. The machine was purchased in the thousands by finance workers (in particular, bond traders) on the strength of this one program. The next example is another spreadsheet, Lotus 1-2-3. Sales of IBM's PC had been slow until 1-2-3 was released, but only months later it became the best-selling computer. A killer app can provide an important niche market for a non-mainstream platform. Aldus PageMaker and Adobe PostScript gave the graphic design and desktop publishing niche to the Apple Macintosh in the late 1980s, a niche it retains to this day despite the fact that PCs running Windows have been capable of running versions of the same applications since the early 1990s.
>
> There have been a number of new uses of the term. For instance the usefulness of e-mail drew many people to use the Internet, while the Mosaic web browser is generally credited with the initial rapid popularity of the World Wide Web. The term has also been applied to computer and video games that cause consumers to buy a particular video game console or gaming hardware to play them; two related examples of this are Halo and Halo 2, which turned the Xbox console into a commercial success that it would not have been otherwise. Likewise, the 1993 adventure game Myst compelled many PC users to add CD-ROM drives to their computers, as the game was not available on floppy disk. See killer game for more information.
>
> Developers of new platforms now tend to put a lot of effort into discovering or creating the next killer "app" for their technology, in the hope that it will be the breakthrough needed to get the technology adopted. This has led to the burgeoning list of features on, for example, mobile telephones, such as text messaging, digital cameras, etc., though many maintain that the killer app for telephone technology is, and always has been, live peer-to-peer voice transmission.
>
> Computer experts sometimes use the phrase with reference to other technologies to explain its significance to laypersons. In this context *a killer application refers to a certain usage of that technology that makes the technology popular and successful. This usage of the term is especially prevalent when the technology existed before but did not take off before the introduction of the killer application.* Examples for this:

technology	killer application
the telephone (microphone and earphone)	talking to distant beloved ones via a telephone exchange
the steam engine	railway transport (although its factory use was of prior significance)
rubber	the pneumatic tire, or raincoats
the gasoline engine	the automobile (though motorboat "one-lunger" engines were the first widespread sales)
Internet	e-mail

There is also a fairly well-known book by Larry Downes and Chunka Mui on this topic: Unleashing The Killer App

From "Unleashing the Killer App", retrieved July 6, 2006 from http://www.wspromotion.com/newslettervol151.html:

Unleashing the Killer App

Larry Downes & Chunka Mui define a "killer application" as "a new good or service that establishes an entirely new category and, by being first, dominates it, returning several hundred percent on the initial investment." As they explain in Unleashing the Killer App (published by Harvard Business School Press), the primary forces at work in spawning today's "killer apps" are both technological and economic in nature. "The technology we are concerned with is the transformation of information into digital form, where it can be manipulated by computers and transmitted by networks." Digital strategies are needed to achieve market dominance.

The co-authors divide their book into three parts: Digital Strategy, Designing the Killer App, and Unleashing the Killer App. In Part I, there is a brief discussion of one "killer app" in the Middle Ages, the stirrup, which added mounted cavalry to the battle equation. The "lowly stirrup" played a singular role in rearranging the political, social, and economic structure of medieval Europe.

In The Lever of Riches, Joel Mokyr identifies countless other "killer apps" throughout history such as paved streets and sewerage disposal; the lever, wedge, and screw; the heavy plow and three-field system; the weight-driven mechanical clock; spectacles; the printing press; the steam engine; the telegraph; the bicycle; ...each of which also had a truly profound impact.

To repeat, Larry Downes & Chunka Mui concern themselves with the technology of transforming information into digital form. Thus in Part I, they examine the "killer app", explain what they call "the new economics", and then shift their attention to the nature of a digital strategy. They dully acknowledge the disruptive power of "killer apps" which can suddenly destroy the equilibrium of what appeared to be stable systems of commerce and government. For them, business change now originates with digital technology; more specifically, with "killer apps." Strategies are needed to manage (to the extent possible) their impact to achieve sustainable competitive advantage. These strategies must accommodate three new forces: digitization, globalization, and deregulation. The "dirty little secret" to which Gary Hamel has referred is that the strategy industry "doesn't have any theory of strategy creation." The success of any digital strategy may well be the result of what Hamel calls "lucky foresight." Downes & Mui seem to agree with Hamel while offering, in Part II, what they refer to as "a few rules of thumb." They suggest three stages of "killer app" design and carefully

explain each. They identify 12 specific principles on which to base the design process. In Part III, they shift their attention to "Unleashing the Killer App" and correctly stress the importance of communication, one which "speaks with the language of ideas, scenarios, options, and what-ifs."

In Chapter 7, the reader's attention is directed to two major corporations, McDonald's and VEBA AG, which illustrate digital strategy in practice. These are, in effect, mini-case studies. It is important to point out, however, that effective digital strategies are not the sole province of major corporations such as these. *A "killer app" can quickly increase or reduce the size of any company.* Consider the fact that a single dry goods store in Kemmerer (Wyoming) can become the J.C. Penney Company which, in turn, now struggles (with mixed results) to compete successfully with a company whose own history can be traced back to the Walton 5&10 in Bentonville (Arkansas). Downes & Mui assert that "Developing digital strategy...requires components of both problem-pull and technology-push...operating together in a well-functioning organization [in which] the process becomes not only circular but indistinguishable...in a pragmatic, indeed opportunistic, response to the new digital environment."

In the final chapter of Unleashing the Killer App, Downes & Mui suggest that cyberspace "is fueled by free computing power and free bandwidth...and free software." Consequently, "the social conditions that resulted are raw, and the nature of the business climate, by necessity, less developed." As with The Golden Rule dry goods store (in 1902) and then the Walton 5&10 (in 1950), today's companies must seek out new areas of opportunity and start doing business there. "Those who make the transformation by developing a digital strategy are choosing to engage the frontier on its own terms, just as their counterparts from Europe did in settling the New World."

Larry Downes & Chunka Mui have outlined the process of digital strategy, explained the twelve design principles, and described the experiences of organizations that are transforming themselves so that they can unleash "killer apps." Which companies will conquer the "frontier", whatever and wherever it may be? Which companies will not? In the Digital Marketplace, we won't have to wait very long for the answers. Probably in what seems to be about five minutes.

I hope this helps in your future marketing decisions.

[07/28/06] Of course, *it's perfectly possible to adopt without a killer application of any kind.* Compare with #4's decision to take up bike commuting: there were plenty of alternatives available, and bikes in no way constituted a killer application that none of the others could address. However, they were a better fit with his ideal image of himself. (*Does this make a difference in affective vs. functional adoption?*)

[08/09/06] What #4 says here in (17:126) is interesting in terms of substitution. "I think Flexcar would work better for me if I didn't own a vehicle. I think Flexcar has too high marginal costs for me. *Owning a vehicle and then having Flexcar negates really the value of Flexcar aside from, 'I got somewhere by bike or bus, now I need a vehicle.' So I don't use it as much any more.* Does Flexcar have a killer application only when car ownership is not an option?

[11/10/06] I think "clincher" gets closer to the sense that I'm trying to convey here than "killer application", a metaphor I've always found way too violent for my tastes. Retitled this memo from its original title, "killer applications"

[12/29/06] See today's entry for "successful advocacy and opinion leadership". Clinchers help generate buzz.

M.18. Coadoption?

[03/01/06] This seems to be a case of ***coadoption***, the adoption of two technologies which complement each other and offset each other's weaknesses vis-a-vis a substitute (e.g., replacing single passenger car with the combination of car pooling and rail, or car sharing and rail.)

I've never run into that before in the literature...but informant #5 referred to the phenomenon as "multi-mode" transportation.

[07/19/06] Coadoption strikes me as an important *conflict resolution strategy* (e.g., workaround for a use block or other conflict.)

[07/31/06] In (17:75) #4 discusses having all of his transportation needs pretty well covered -- walking or bikes on the Reed campus, and taking the bus those times he had occasion to go into town. Living in the village-like campus atmosphere, he was pretty well self-contained. (Unlike, say, CMU where you have to go for quite a walk just to get to the grocery store.) It was a combination of technologies to solve particular needs rather than one technology which did it all.

M.19. Collapsing decisions

[03/01/06] Here is an example of collapsing the commuting decision into a general category -- 'how bad is the commute?' -- rather than considering each need individually. Is it cognitively simpler to reach decisions in this way? (cf. political polling with their 'on the right track' questions). Related to Janis and Mann's conflict theory, with its cancellation and collapsing mechanisms?

[07/06/06] Perhaps the ease or difficulty of decisions is a function of whether they can be easily collapsed into 'good for me' or 'bad' for me' categories. Perhaps it's too cognitively expensive for people to leave decisions unresolved (cf. the Certainty Effect from Tversky and Kahneman (1981); Zeckhauser's Russian Roulette experiment, discussed in Plous pg. 99).

[07/11/06] #5 provides an example here of how the individual needs collapse into one general category, 'it seemed like a good idea at the time.' I think there's something important about our psychology lurking in this deceptively common expression. It tracks with political science, where pollsters ask 'do you think the country is on the right track?'

[07/13/06] When searching for something else in my PSY 510 lecture notes I noticed that collapsing is explicitly included as part of Montgomery's dominance structuring theory (along with bolstering, cancellation, and deemphasis.) It was both a confirmation and a 'duh!' moment, as I should have remembered that a long time ago. I keep coming back to dominance structuring as a crucial mechanism in how conflicts are reconciled during the collapsing process.

[12/20/06] I ran across another reference to this behavior in Miller's classic 1956 paper, "The Magical Number Seven, Plus or Minus Two" (pg. 16)

> "[T]he span of absolute judgment and the span of immediate memory impose severe limitations on the amount of information we are able to receive, process, and remember. *By organizing the stimulus input simultaneously into several dimensions and successively into a sequence of chunks, we manage to break (or at least stretch) this informational bottleneck.*"

[06/25/07] There's an interesting moment in the decision process that is extremely familiar, yet seldom remarked on: the sense conveyed by linguistic cues like *"Now then..." or "Having said that..."* It's a conversational marker to indicate that the speaker is moving on from the previous subject or is extending the argument in some way; but it also signifies something important in the cognitive process, the moment when the topic is collapsed.

M.20. Collective adoption and the origins of desire

[05/16/07] At IAMOT 2007. The foundation of collective adoption is individual adoption. In the case of organizations, is is the decision to maintain one's allegiance to the group through continued employment or membership. Habit plays a part here. Once allegiance becomes habitual it is no longer reflected upon; subsequent decisions are then bound by this first, primary decision to adopt the group. *Thus does "adoption" enter into other meanings here, as to "adopt" a child into a family.* With time and the

deepening of habits of mind, it becomes literally unthinkable to entertain the notion of rejection simply because of the profound personal mental, social, and functional disruption which would ensue.

This harkens back to *autogenesis*, and the distinction between *teleological and teleonomical intent.* The individual experiences endogenous, teleological intent; as the ties binding the collective group become stronger, its teleonomical intent becomes teleological as well, passing through an intermediary chaotic phase of "quasi-teleological" intent ("I just can't help myself!")

Can any system possess a teleological goal without reference to a meta-level system? The balance of nature (Darwin, adaptation through natural selection) would seem to require reference to a meta-level purpose; otherwise balancing feedback could not arise. The very absence of a goal in evolution seems to imply that it must be present at a higher level; otherwise the feedback would be self-reinforcing rather than balancing.

In any case, desire would seem to arise from the interaction between micro-level neurological processes and the macro-level sense of "self". Evolution has caused the individual cells of our body to adapt to their environment in order to survive; over time this constraint has solidified to the point where the individual cells can no longer survive as independent agents, but only as part of the collective whole. In this way, the collective has acquired a unity of action which emerged after a chaotic period akin to the kinds of collectives which we call human social organizations.

Adoption is part of the mechanism by which individuals become collective structures, and over time synthesize into individual actors themselves.

[07/31/07] See Zimmer (2007) -- discusses applications of Martin Nowak's game theory work to evolution. Nowak argues that evolution consists of three processes: cooperation, mutation, and selection. By cooperation he discusses phenomena like sterile worker bees caring for eggs in the hive, and how this form of cooperation came about (another example would be cells in the body, which cooperate even to the point of dying on command.)

M.21. Deal-Breakers

[07/19/06] #10 refers to a *"deal-breaker"* here -- is that the opposite of a "killer application"? An unmet need so important that it overrules all other favorable need-tech pairings?

In modeling terms, this might correspond to a technology which is in the selection set for one need, but the inept set for another need. Thus, **there is a difference between a killer application and a primary need, or between a deal-breaker and a primary need. The killer application/deal-breaker refers to the teme -- the need-tech association. The primary need is only one part of the killer application/deal-breaker**. The same thing goes for perks and drawbacks.

And what happens when a deal-breaker is placed in opposition to a killer application? Do you get involuntary adoption or rejection in that case? (e.g., having to agree to an onerous contract just because otherwise there is no way to obtain some key advantage.) This is how monopolies are built...perhaps Krackhardt's studies of network power configurations could shed some insight on how this conflict is resolved.

[08/23/06] In reading #8's comments here in (23:32) that a use block is a kind of deal-killer -- a condition that precludes using a technology, no matter how attractive it is or how much you'd like to adopt it. It simply overrides all other considerations -- and on that basis perhaps it's not a complete opposite to a killer application, since a killer app doesn't necessary override all other considerations.

[10/09/06] #14 provides a further example in (26:39) -- she is unable to bike to work because of all the stuff she would need to transport. In (26:42) it's pretty clear why #14 doesn't use her bike to commute: this candidate is dominated by other options. She's already getting exercise at the health club; she's not driving that much to begin with; there's no real cost advantage, since she's still going to be paying for the TriMet pass; she's going to be encumbered with too many things to carry on the bike. "Well, right now, for me this isn't going to work." However, she did give it serious consideration, and for me what

makes it interesting is that she really tried to resolve the conflict between these needs, but ultimately she encountered a use block that she was unable to resolve.

M.22. Design-time vs. run-time and structured vs. anarchic perspectives

[10/24/06] I've been thinking about the event-state diagrams I'm producing, and how these are pretty good at capturing some of the real-life context behind decision making. Nevertheless, they necessarily oversimplify that context. This seems unavoidable; even the most microcoded grounded theory or ethnographic approach is going to have to oversimplify some context. Real life is just too rich -- and I would argue, irreducably complex in the sense that it is inexorably bound up with history. It is not only emergent, it is also contingent (Heidegger had some remarks on this subject -- see Collins and Selina pg. 48, 79, 82-83. See also Heidegger's response to Sartre in Thody and Reed pg. 59-61; also Appignanesi and Zarate pg. 124-125.)

Just as the dynamic trajectory of a chaotic system is its own shortest description, so too is life experience contingent on its history (and exactly when does that history begin?) There is no more economical representation of life context than the life experience itself -- which is inherently subjective.

I began thinking about why this may be, and it hit me that this really goes to the heart of the quite necessary tension between the structured vs. anarchic perspectives, and between Levi Strauss' analytic and synthetic poles. These aren't really endpoints of a continuum after all (I always had a little trouble with Mintzberg and Langley here) because they're tapping two different dimensions. One dimension is structural and deals with patterns and generating processes; it is fundamentally static and atemporal. The other dimension is temporal and deals with history, origins, and contingency; but cannot look at structure because a life lived is its own shortest description; ***life experience is irreducably complex.*** The structured perspective discounts history; the anarchic perspective discounts generating processes.

This really goes to the heart of what I'm trying to express with the design-time vs. run-time distinction in computer science. A design-time description is static; it describes generating processes, but instantiation does not occur at design time. An object can only be instantiated at run-time, and in the act it acquires a history: its construction, its thread of execution, its destruction. Run-time structures are inherently emergent and contingent upon this history; agent-based modeling is inherently probabilistic (and different from deterministic equation-based modeling) because it is impossible to completely specify the state space of such a system.

[11/25/06] Perhaps the distinction I'm drawing between run-time and design-time structures parallels the distinction between phenotypes (the emergent physical appearance of an organism) and genotypes (the underlying biochemical processes which give rise to a phenotype). This occurred to me after reading the Wikipedia article on memes (see today's entry in Temes and Memes); but I'm not an expert on evolutionary biology, so I need to be careful in drawing such analogies.

M.23. Discounting

[07/21/06] This is surprising and puzzling: why did I discount the free Flexcar credit in order to pay cash for the taxi ride? See notes on discounting in Psy 510; in reference to 'comping the house' see the Weber-Fechner law, which states that the psychological impact of something dwindles the more of it you have.

[07/26/06] Seems like in (14:105) that discounting is an important part of #10's unconscious mental strategy for constructing a frame which allows him to operate in the domain of gains, no matter what the outcome is. If a negative outcome occurs, then he can discount the importance of those needs which would ordinarily lead him to operate in the domain of losses. This is part of the de-emphasis process which Montgomery describes.

M.24. E-mail as a memory supplement

[03/09/06] The ability to keep e-mail around ("hoarding" e-mail) is an interesting and comparitively recent cognitive strategy. Given the increased pace at which information bombards us -- and our limited ability to respond to just a fraction of all that info -- e-mail serves as a kind of supplemental personal memory. We no longer need to retain the details of the info; we just need a few snippets of detail which we can use to search for the entire record. It's rather like how we use vague associations (sound, taste, etc.) to locate past memories. From an evolutionary standpoint this would be a much more efficient strategy than maintaining a voluminous memory of details.

But *what, then, do we use the freed-up capacity for?* Perhaps Levi-Strauss' pole between the analytical and the synthetic comes into play here; by surrendering detail, we gain the ability to make generalizations and recognize broad patterns.

[7/10/06] Perhaps we free up that capacity because there is an ongoing cost associated with keeping problems open-ended -- in which case this phenomena may be related to collapsing decisions. Keeping the e-mail around means that collapsing need not mean burning bridges behind us; in principle we can always go back and root through our old e-mail to try and find that piece of information that didn't seem important at the time, but now might hold the key to solving some current problem. Thus, e-mail facilitates collapsing? (The alternative perhaps being a metaphorical "mental pile" of sticky notes, colored index cards, etc.)

M.25. Emic and Etic

[11/10/06] Ever since I interviewed #25 for the winter bikes case (on September 14) it's dawned on me that adoption is similar in certain respects to religious belief. About ten years ago, when I was working on a book exploring the relationship between religion and prejudice, I read Batson, Shoenrade & Ventis's book Religion and the Individual: A Social-Psychological Perspective (1993). One thing that's always stuck with me about this book was its unpacking of religious belief into three dimensions: religion as means, religion as end, and religion as quest. This really resonates with me in this study, and I notice today that it's been right in front of my nose since the very beginning of the analysis: functional, social, and self-image needs correspond very closely to religion as means, religion as end, and religion as quest respectively.

At the same time, there is a second way of looking at the needs which drive adoption in terms of clinchers, perks, drawbacks and show-stoppers.

[11/29/06] I was reading the Martino (1993) book on technology forecasting today, and I was struck by the distinction he draws between technological and functional issues: the former are focused on the attributes of a technology, whereas the latter pertain to user needs. He says it's important to maintain this distinction, and I fully agree. That started me thinking about Linstone's three perspectives -- technical, organizational, and personal -- and how this set differs from the three I have arrived at. It isn't just that the names are different; it's that *the technical-organizational-personal perspectives are "etic" whereas the functional-social-personal perspectives are "emic". "Emic" is an ethnographic (more specifically, anthropological) term which refers to things that make a difference to an insider, whereas "etic" refers to things that make a difference from an outsider's view.* Agar (2005) argues that the emic perspective is particularly important in agent-based modeling, to model things which make a real difference in the world being described. As he sees it, some "artificial societies" are more artificial than others:

> "...[A]n emic model results in a different sensitivity to program details and what they mean, because program details have a phenomological analogue in the world of real-life agents...it raises issues about the translation of ethnographic analysis into computational form. [...] Emic models sharpen the question of what an agent-based model should include to serve practical goals."

Agar goes on to say that while the "emic" and "etic" terms are useful at a general level, "a closer look reveals many conceptual potholes...the distinction between emic and etic isn't as straightforward as it seems."

> *"If you're going to model what human agents do in some corner of the world, you can adopt theoretical frameworks that lay out dozens or even hundreds of variables that* ***might*** *make a difference. Or you can explore that corner of the world and listen and learn, from the point of view of living breathing agents, what it is that* ***actually*** *makes a difference from their point of view.* But a major qualification is necessary here, one that is well known by ethnographers but important to foreground for readers who have no such background. "Emic" *never* means "everyone told me that this is exactly the problem and this is how to solve it and they are all exactly right." *"Emic" means* ***a difference that makes a difference*** *in those agents' world, even if they are not aware of it. Emic goes beyond the consciousness of any individual agent, including any individual ethnographic agent. [...] The important part of "emic" is that you, the outsider/modeler, learn some key differences from them, the living agents.* The significance of those key difference may well not have been known, to the outsider, before the research. Possibily the outsider knew *of* them, but he/she didn't really understand how they played the roles that they did."
>
> *"But then modeling the difference means you need a computational translation. [...] Is there any sane way to tell a computer what these propositions mean?* Consider the "etic" at this point. In the case of risk and the impact of experience, there are, in fact, etic research traditions that focus on exactly those concepts, namely diffusion of innovation and prospect theory. Etic they may be, but in this case they intersect with emic differences and let us model them. Notice several things:
>
> 1. Selection of etic/theory was ***directed*** by an important emic difference rather than being selected ***a priori***.
> 2. The etic research tradition had an elaborate pedigree with numerous studies in different context and geographical areas.
> 3. So elaborate was the etic tradition, and so robust were its key results, that one can argue that it plausibly represents ***universal*** aspects of the human situation.
>
> "Ethnography can be defined as making sense of human differences in terms of human similarities. The differences -- the emic -- are always in the foreground, since they are the primary focus of any ethnographic study. But similarities -- the etic -- are featured as well, at least enough to connect the differences in the agents' world with the audience's way of understanding how the world works. *Differences are the problem; similarities are the solution. Similarities are where the etic helps out."*
>
> "This is a version of "emic/etic" that makes sense for ethnographic research and for modeling its results...With development of an ethnography/agent-based modeling tradition, we might notice that particular theories are repeatedly useful and appreciate how those recurrently useful theories work together. We might begin to build an etic structure, a theory hybrid, backed by relevance to many different cases. We might, in short, move towards something previously available to the wise and the insane -- an actual theory of how the social world works that helps explain across many kinds of differences, a theory shaped by robust emic relevance rather than proclaimed universality (often false) and predictive power (that often doesn't work)."
>
> "If nothing else, "emic" reminds us that models of the human world have to have clear connections with what the humans who live there are actually thinking and doing."

M.26. Exposure as an interrupt

[03/16/06] Here #1 says that she was prompted to take another look at Flexcar because I mentioned it in the telephone prescreening (BTW, I didn't suggest that she look into it, I asked how often she had used it.) This suggests that interrupts don't just function as a break in the decision process, but can also function as external events which punctuate the background. It's kind of an "inside out" way of looking at interrupts from that which I'd previously thought of.

M.27. Flexcar stress

[03/01/06] Could the regret associated with 30 minute vs. 15 minute charges actually be discouraging the frequency of Flexcar use? (Sounds like a good candidate for a social simulation!)

There are two sources of anxiety #3 alludes to here: paying extra (presumably a minor issue, since PSU is footing the bill) and **the potential of inconveniencing someone else**. The latter source is likely to be an important source of low-level stress associated with Flexcar use, since every time you use it there is the potential for an innocent mistake to turn into a highly disruptive and socially embarassing episode. This bears watching in future interviews with Flexcar users.

[03/31/06] Based on #4's interview, it appears that the cost of underestimating the time block is very significant indeed! The Flexcar user may be required to pay for a taxi trip if someone was supposed to follow them, and I don't think PSU covers it! Flexcar may have made the cost of making a mistake too punitive.

[07/21/06] As I discuss in my Flexcar journal, *Flexcar users are caught on the horns of a dilemma -- between regret, if they overreserve the car and pay for unused time -- and dread risk, if they underreserve the car and get fined for late return and cab fare.* Flexcar is asking too much by expecting that its customers can accurately forecast factors which are beyond their control which may influence rental time. In response, institutional customers tend to overreserve these cars because the cost of the service is borne by employers like PSU. But over time this may drive away customers who are not affiliated with such institutions (or at least discourage their participation), and might lead institutional users to discontinue a service which they view as a 'perk' or at best a way of essentially purchasing subsidized parking spaces (see interview with Dan Zalkow).

[10/09/06] In (26:32), #14 supports the idea that Flexcar stress might result more from concern about inconveniencing the next person than fear of financial penalties. But she also mentioned that concern about unforseen delays -- e.g., someone parked in the Flexcar space when you try to return it -- is a source of stress as well. #14 confirms the tendency to overschedule Flexcar to avoid the return penalties.

M.28. Forced Adoption

[11/30/06] It seems remarkable to me that I've managed to get all the way through the PP+ case without writing a memo on forced adoption -- although in fact there's a huge one that's been sitting right in front of my nose the whole time: being forced to use a car.

I woke up just now thinking about being forced to upgrade computer software. I might have been thinking of my subscription to Norton Internet Security, which I had to renew a couple of days ago (and Symantec manages to always make it a royal hassle to give them my money.) This practice of forcing the consumer to constantly upgrade just to maintain the status quo, where you can't simply continue to use what you've already got -- tying the innovation to "network externalities" as Brian Arthur says (he was cited in the Linstone 1999 article I just read on complexity science and forecasting). There's something deeply troubling about this, and it finally came to me just now:

What would happen if everybody did this?

Of course, it seems like we're getting closer to that point every day, as companies figure out that forcing people to adopt is a great way of enhancing their own revenue stream. But as more and more companies do so, consumers are being treated as a nonsustainable resource -- almost like they're being 'clear cut' by rapacious companies who are only out for their own bottom line, and to hell with the long term consequences for society. It's a classic commons dilemma.

- As consumers are hit with more and more unreasoning, unarguable demands for upgrades, they are going to have less and less disposable income. It is simply not sustainable over the long run.
- As society gets hit with the sheer waste of all these disposable, useless, obsolete software products, what is going to be the long-term consequence of this sheer waste? (Software waste is invisible; hardware waste winds up in the landfill. How many computers are actually being recycled? How much of the Earth's limited resources is just winding up in the landfill?)
- As computing becomes ubiquitous, what is the technological consequence of having to support ever-increasing demands for upgrades? What happens if your toaster stops working because it's software can't communicate with the house anymore? As absurd as it sounds (given the simplicity of a electro-mechanical toaster sans software) this is a real possibility if we keep sticking software everywhere, simply because marketers are under pressure to constantly add new features to encourage sales. (Think of Powerpoint)

Featuritis has longer-term consequences than just making life more difficult and frustrating for individuals. It is part of a complex web that forces consumers to upgrade, and when it is widely enough practices will have serious implications for society.

M.29. From the inert set to the selection set

[07/24/06] Here #10 gives a very nice description of how he began to entertain a candidate he once would have dismissed out of hand ('Yeah, right!'). A number of elements are present here.

- *A prior history with bicycles that was favorable. In this case that's his experience in Eugene, and it's interesting that he clung to this favorable view of bikes despite his very negative experiences in Memphis.*
- *Positive role models.*
- *An obtainable vision of how the substitute might be worked into one's life.*
- *Regret about purchasing the transit pass.*

I particularly think the "I took the emotional leap of just doing it" stands out. "Giving it a whirl" is an interesting phenomena in its own right...a way of cutting short the analysis paralysis. Fortunately bicycles are fairly easy to try on a limited basis -- provided that you own a bike!

[08/01/06] See the "ah ha!" experience for more insight on this phenomena. #4 has several interesting things to say about this in quote (17:84).

[08/08/06] #4's statement in (17:114) would tend to confirm some aspects of what I described above -- how he got back into cycling after a hiatus of several years:

- Prior history.
- Positive role models.

However, there are *important differences in how #4 and #5/#10 approach adoption.* #10 frames the issues in largely *functional* terms: he is very analytical and wants to find the most cost-effective way to get to work without having to pay $8 a day for parking, or pay for two months on the TriMet pass that he saw no benefit for. #5, while of a more athletic bent than either #10 or #4, is also coming at bicycle commuting largely

from a functional standpoint (any socializing and identity construction he would do would tend to be associated with recreational cycling, not commuter cycling.)

#4, on the other hand, frames the issues from the outset in largely *social and aesthetic* terms: "I think we definitely differentiate ourselves. We would not be cyclists that would wear [racing] jerseys [laughs] so we're in that category of not taking cycling seriously in terms of athleticism, but more of a larger...I don't know, it's more of an identity issue than it's sort of an athleticism issue. We get around biking, instead of for health, but because that's what you have to do, that's sort of the way to go." He bikes because it is an aspect of belonging to a community, rather than the other way around.

This parallels *childhood experiences* where all your friends were riding bikes, and if you wanted to keep up with them you had to ride, too. Riding cements the social bond and one's sense of belonging. There is an egalitatian aspect to (noncompetitive) recreational biking, where everybody has a bike, everybody belongs, everyone is equal. (Compare to the *Slug Velo* ride, where no one is left behind.)

So maybe *regret* is a factor here after all: the desire to avoid the powerful feelings of regret that may result from watching everyone else in your social circle ride off and leave you behind...regret is incommensurable, so "the desire to avoid feelings of regret" is a wide-open statement that has to be understood in a specific context. For #10 it was regret about purchasing the transit pass; here it's regret about being left out of one's social circle.

It's also important to point out that adoption which is framed in social and aesthetic terms tends to involve recreational biking first, then (perhaps) commuter biking after that once riding is firmly established: "Hey, maybe I could ride my bike to work!" The biking identity leads the informant to search for additional potential applications.

[08/09/06] #4's in vivo quote in (17:121) tends to reinforce this conclusion that the desire to avoid feelings of regret is a powerful social motivator:

> B: So talk to me about this period from October to April. I mean, I would think the idea of pitching...if I were going to pitch something to my friends, saying 'You ought to commute by bike!' I wouldn't pick October to start making the pitch.
>
> #4: Well, yeah, I think it was because it was the end of the summer. It's like the zenith, October is still nice. Yeah, we were still hanging out...*I think part of it, too, that friend of mine that summer, we were doing a lot of stuff together, and he was going to get to where we were going by bike regardless. So there's sort of an inclusion - if I got on a bike then we'll both go over the same way, versus me bumming a ride from somebody, or hopping on a bus. It just wasn't going to match up with what we're trying to do together.*

[08/24/06] In her early stages of considering Flexcar, #8 makes some remarks that track with aspects of what I observed earlier with #10: an obtainable vision of how the technology might fit into your life:

> #8: Because the kids, it's on separate days, so two times a month we do this back-and-forth, back-and-forth. *Whereas I could walk over to behind the Urban Center and hop on a...get a Flexcar and drive out, and come back. That would be really nice to do, because I can't really take the bus home back in the middle of the day, #12 - I mean, that would be an extra hour, at least.*

Although, from (23:63), it's clear that #8's ideal vision of how Flexcar would work isn't going to jive with the reality of the service.

M.30. From the selection set to the inept set

[07/19/06] #10 and #5 give examples of moving from the selection set to the inept set -- rejection. It seems to me that *one of the major differences between value-centered adoption and the construction of a technology-centered identity is that in the former case rejection is*

just a matter of changing your mind. But in the latter case rejection a traumatic experience that jeopardizes the identity which has been constructed, risking some disruption of the personality! In that case, the safer course of action may be to just move the technology to the inert set rather than the inept set; one 'grows away from' using it rather than repudiating it, and jeopardizing one's identity and interpersonal relationships.

M.31. From the selection set to the inert set

[07/19/06] The gist of what #10 is saying here is that he doesn't want to get rid of his car, he just wants to be selective in how and when he uses it. This also seems to track with what #1, #3, and #5 are saying -- they don't view cars as an addition which must be stopped cold turkey, but rather as a resource to be managed intelligently and selectively.

But is this rejection? It doesn't seem to match any concept of rejection which is discussed in the literature (e.g., Eveland 1977?, Rogers 2003).

[07/27/06] #4 says that he stopped using his bicycle for a while when he first moved to Portland -- but he didn't reject it, he just discontinued using it for a while. This I think points up the fallacy of equating disuse with rejection. He just temporarily moved that option from the selection set to the inert set (or perhaps the inept set, since he didn't own a commuting bike at that point?) There's something important here that points up the distinction between attitude toward a technology and actual use of that technology; one can have one without the other. See discussion of the KAP gap from Rogers (2003).

I'm beginning to suspect that there's something amiss in this selection set-inert set-inept set business from the marketing literature. It's kind of a blunt tool for getting at some subtle nuances of technology adoption...

In (17:45) #4 makes it clearer that the reason he stopped using his bike in Portland was that 1) he didn't leave the Reed campus very often, and 2) he didn't have a commuter bike. Thus, he had no need of commuter biking.

M.32. Functional needs vs. self-image needs

[03/01/06] #3 notes here that the biggest factor in her decision was the wear and tear of commuting. The environmental impact was in there, but it wasn't the driving force.

[10/09/06] In (26:30), #14 gives a good example of a primary need which is not a functional need: she bought a bike for recreational purposes, so that she could ride with her friends for fun. Fun is inherently nonfunctional; it is an emotional need and an end unto itself. In this case, the social bonds which are strengthened during the bike ride are also nonfunctional, in that they are not being used (in this instance) to achieve any sort of functional purpose. While it is true that friendship ties can be employed to serve functional purposes (cf. #18) the deeper truth is that we seek human companionship for its own sake; it is a core emotional need. Its functional uses follow from friendship. It is generally frowned upon to seek out relationships for the sole purpose of achieving functional ends. No one like to feel like they are being used rather than sought out for their own sake.

[06/22/07] See today's entry in functional needs vs. social needs.

M.33. Functional needs vs. social needs

[03/02/06] It looks like the functional needs are the driving force here, then once they're met there are additional opportunities to satisfy social needs. This also suggests that social consolidation may be a signifier of later adoption stages.

[03/15/06] It's interesting to compare the functional vs. socioaesthetic dimension with Maslow's heirarchy of needs, which places functional needs (food, shelter, safety) at the base of the pyramid, whereas social needs (self-actualization) are placed closer to the pinnacle.

[07/10/06] Perhaps the dominance structuring and diff/con phenomena occur because of the desire to collapse as many open subproblems as possible, thus obtaining the *smallest local minimum in cognitive cost?*

[10/09/06] See today's entry for functional needs vs. self-image needs.

[06/22/07] Yesterday I attended a Cycling Brown Bag event on Why People Don't Bike, and Linda Ginenthal presented findings from a recent survey conducted by the City of Portland. She expressed some frustration when people would just reply "I don't know" when they were asked point blank why they didn't ride more. She sorted these into two sets of reasons, objective and subjective.

When she said that, a light popped on and I suddenly had the language to describe something that I've been struggling with for some time -- *why do people tend to offer functional narratives as defenses rather than social or personal ones? The answer comes from attribution theory. Objective attributions are easier to defend because circumstances or situations are not easily altered; other people would presumably do the same things in similar situations or circumstances, so an individual cannot be blamed for making an incorrect decision. Subjective attributions are harder to defend because they involve personal actors who could presumably choose to act differently, and therefore the person could be blamed for making an incorrect decision. This implies that attribution theory is related to regret and dominance structuring. Dominance structuring is the after-the-fact search for objective attributions to bolster decisions which can only be defended on subjective grounds. Regret occurs when a set of objective attributions cannot be found to defend and justify an incorrect decision. The distinction between good vs. bad decisions (referring to the process) and correct vs. incorrect decisions (referring to the outcome) also relates to this distinction between objective and subjective attributions. In classical decision theory, a good decision making process seeks to minimize the influence of subjective personal intuition and maximize objective information about circumstances and situations. A desired decision outcome cannot invariably be related to good decision making, nor can an undesired final result be traced to bad decision making (Baird 1989, pg. 14). However, if a good process is followed then the outcome (either good or bad) can be defended more easily because it can be attributed to objective rather than subjective factors.*

M.34. Grounded Agent Modeling

[08/19/06] I guess what seems to me kind of a radical notion is that you can use software to do more than just program computers. *You can also use it as an aid in thinking, to express ideas* -- well, ideas of a certain kind, anyway. Software can be used as a language of theory, to help express ideas more clearly, and as a way of testing whether those ideas actually make sense and are self-consistent; to explore their hidden implications, and to see how one idea fits or meshes with another idea in a way that might allow them to be used in combination.

It seems to me that's what Meyer is driving at here: "Over the years many articles and talks have claimed to examine how software engineers could benefit from studying philosophy, general systems theory, 'cognitive science', psychology. But to a practicing software developer the results are disappointing. If we exclude from the discussion the generally applicable laws of rational investigation, which enlightened minds have known for centuries (at least since Descartes) and which of course apply to software science as to anything else, *it sometimes seems that experts in the disciplines mentioned may have more to learn from experts in software than the reverse...the profession [of software engineering] has not fully realized the epistemological implications of its own work. Eventually someone will come and explain what lessons the experience of software construction holds for the intellectual world at large.* No doubt abstract data types will figure prominently in the list." (Meyer, 1997, pg. 148)

[10/28/06] Two different but complimentary approaches to analysis were used to construct the structural and behavioral models.

The Structural Model

The structural model was constructed using a grounded approach to coding and analysis. During open coding a provisional set of codes was identifyed and used to tag important personal, social, and functional issues along with other relevant factors such as commuting needs and process boundaries. This initial set of codes was revised and expanded somewhat during the analysis process, but stabilized fairly early on. These codes was used to index certain segments of the transcripts for later analysis. Memos were used in conjunction with coding; CAQDAS was used to establish an evidence trail and record the emergence of themes over time.

During axial coding a set of network diagrams were deveoped to identify interactions between categories and identify the properties and dimensions of the categories. The categories which emerged during this process included:

Self-image and transportation: to the wider context of transportation decisions and how these relate to the maintenance of self-image: life arc, plans, violations, conflict, etc. Themes of personal identity and meaning are central to this category, such as what it means to be a kid, a grownup, or a professional.

Development of an initial interest. This category explores the interplay of attention and intention. Important properties include the 'ah ha' or eureka experience; how an issue comes to be 'on the radar'; how one becomes 'bitten by the bug'; how perceptions and interest shifts as new experience is gained; and the nature of the events which prompt these experiences.

Exploring possible uses for an innovation, an axis whose dimensions span the range from killer applications, through perks, to a wash, to a drawback and finally to a show-stopper.

Getting over the procrastination hump, a category which explores the origins and nature of the procrastination phenomenon in its various forms, and its relation to the technology adoption process.

Thwarted intentions deals with the flip side of procrastination: what happens when choice is involuntarily constrained (e.g., forced adoption; blocked adoption; blocked rejection.) Technology clusters and network externalities are the major properties of this category.

Collapsing the decision is about balancing the pros and cons of a set of options to arrive at a final, summary judgement (collapsing). This category likens adoption to a kind of puzzle to be solved.

Getting comfortable with the idea examines the process of gaining experience and becoming comfortable with one's mastery over the innovation.

Constructing a narrative focuses on the psychological need to construct a story of 'why' one's decisions unfold as they do. Self-image forms the hub of this rather dense category, whose properties include regret, buyer's remorse, irreversable decisions, behavioral traps, 'patting yourself on the back' (aka dominance structuring), discounting, bolstering, making a virtue out of a necessity, maintaining the illusion of control, and framing.

The central category of the case is adoption. Three major axes of adoption are identified: adoption as means, which addresses the functional or utilitarian aspects of technology; adoption as end, which examines the construction of social communities and cultures around certain technologies such as bicycles; and adoption as quest, which explores changes in self-image and personal growth which may be symbolically expressed by the adoption of certain technologies.

A progressive literature search was undertaken in parallel with axial coding. New sources of literature examined, including transportation mode modeling, the philosophy of desire, memetics, and neuropsychology.

As analysis progressed the major structural aspects of the adoption process began to emerge. The basic structural framework is derived from the Humean model of desire formation, together with some of its modern refinements.

The External Specification

A paradigm or set of assumptions for adoption was developed for the theory, and was further refined using contract-driven analysis.

The Behavioral Specification

Event-state analysis was used to construct the behavioral specification. Once the transcripts has been completed and grounded analysis was near completion for the case, each transcript was reviewed and a list compiled of important events, conditions, and needs.

Each entry in the list was identified by time of occurance, a brief description of the event, type of event (functional, social, or personal), and the source paragraph in the transcript.

Once a list had been compliled for the entire transcript, the events were sorted in chronological order.

Similar/duplicate entries were merged, taking care to preserve their sources in the transcript.

Once the final event list had been compiled, an event-state diagram was constructed as a summary of the decision process.

Member checks: each informant was mailed a copy of their own event-state diagram, asked to review and make corrections, and return the diagram to the researcher with a self-addressed stamped envelope.

When all the diagrams had been reviewed and member checked, composite sequence analysis was used to identify common behavioral sequences and construct the behavioral specification.

M.35. "I discovered that I didn't really mind"

[7/10/06] This seems important. #5 originally believed that riding his bike in the dark would be a deciding factor in his decision, based on his anticipation of what it would be like. But then, after he actually tried it, he decided that it wasn't that bad after all. His dread of future consequences was discounted when he actually experienced it, and this shifted his decision in an important way, changing its outcome and increasing his regret for the course of action he had originally chosen. This this led to his trying to get a refund on the TriMet pass.

I wonder if it matters that this happened during a period when #5 was experiencing conflict with his ability to get his transportation needs down pat? Perhaps this ongoing conflict interfered with his ability to "collapse" this decision into a settle routine?

[07/26/06] Similarly, #10 discovers in (14:99) that riding in the rain isn't as bad as he anticipated it would be. *"Leaning into it" seems to be a way of reframing the issues in the domain of gains rather than losses.*

M.36. "I just acted on the options that I knew I had"

[08/17/06] #6's comments here in (20:29) are revealing. During a hurried application of the selection process there was little time to consider alternatives, and no time to consider adoption of a new option (cf. Janis & Mann's conflict theory of decision making.) It was only later, when thinking over the incident in his mind, that it occured to #6 that maybe Flexcar might have been an option. But with the crisis passed, and (apparently) little chance of it happening again, he never really seriously considered signing up for it -- even though it was free.

This is not quite regret, but it's close. If he had thought of an option that interfered with his ability to construct a dominance structure that he did the right thing, then it is quite possible that feelings of regret could have come over him. For example, if the incident had turned out badly, and he subsequently discovered that he could have had a free cab ride courtesy of Parking and Transportation, then he might have very much regretted his decision to risk not calling a cab. On the other hand, as it did turn out he didn't need

the cab; so if he'd called the cab and paid for it himself, he might have felt regret at spending cab fare so frivolously. So much of decision making involves forecasting an uncertain future...

[10/09/06] Regarding #14's statement in (26:23), I suppose there are two ways that needs and candidates get matched up. Having a candidate in hand, and searching for a need -- this feels like an experimental process. On the other hand, having a need and suddenly realizing there is a candidate which could meet that need -- this feels like a "eureka" moment, a sudden recognition.

This is interesting in light of my recent reading of the *Mind and Brain* book. Recognition is an important brain function, and when it's impaired due to damage the results are odd and dehabilitating. In the title story of *The Man Who Mistook His Wife for a Hat*, Oliver Sacks describes loss of recognition as a syndrome of the right brain which impairs cognitive judgement, while leaving intact the ability to form cognitive hypotheses (pg. 19.) This seems to suggest that recognition is involved in reality-testing in some way.

Insight and judgement seem to be a function of the right brain. Perhaps this is why techniques like brainstorming work by opening up the creative possibilities before exercising the critical faculties?

I'm not sure yet how this applies to decision making, but it seems related somehow.

M.37. Intentionality

[02/25/07] Something occurred to me this morning as I was reading this passage in LeShan (2002), "The Psychology of War":

> It is important to note at this point that a "nation" does not exist except in the minds, and on the maps, of human beings -- those of its own citizens and those of the citizens of other "nations." To say "A nation responds..." or "France struck back at the invader" makes for good poetry, but is semantic nonsense. Human beings, usually living in a specific geographical area, and regarding themselves as citizens of a political entity, may act together in a military manner; but there is no meaning in saying that a "nation" takes military action. People often (perhaps typically) act as if their nation is a biological organism, with a will of its own, but it is individuals who act, not nations. Not being clear on this point (and most writers on war have not been) is bound to lead to confusion. (pg. 34)

Yes, that's true; and yet, each of these individuals is in turn comprised of trillions of cells. *From whence does the will arise? And under what conditions do individual agents become so constrained in their freedom of action that they effectively cease to act as individuals, and in so doing transfer the property of will to the next higher organizational unit? When does heterarchy become hierarchy? When does teleonomical or inferred intent turn into teleological or endogenous intent?*

Checkland (1988) describes two types of intentionality: explicit goal-directed teleological purpose, and implicit, apparent goal-directed teleonomical purpose. The existance of a goal in a balancing feedback loop represents a kind of "decision": "The automatic generator may be thought of as a receptor of information about engine speed which 'takes a decision' - completely preprogrammed in the case of the automatic governor - and feeds back 'an instruction' to the valve." (Checkland 1988, pg. 88)

Intention is a crucial mechanism for providing feedback from the macro (emergent) level to the micro (immergent) level. *Reinforcing feedback requires no exogenous mechanism, but balancing feedback does; the existance of a goal cannot be accounted for purely in terms of the system elements, but must be provided exogenously.* And where does this goal come from if it does not arise as "part of" the system? There are some deeper truths here about whether any system can possess a teleological goal without reference to a meta-level system, and thus whether overall balance can be achieved without reference to a meta-level system. Does the balance of nature require reference to a meta-level consciousness? Cf. the discussion of the Ugly Duckling

Theorem in Ilachinski (2004, pg. 67), which was in turn proposed by Watanabe (1985): "A system, whether it is designed to solve a specific 'problem' or evolve in a more open-ended fashion, must decide by itself, and for itself, which parts are more or less important (i.e., have greater or lesser value) than others." Extended to the system as a whole (i.e., the entire cosmos) this seems to imply that if purpose exists in any part of the cosmos, then intentionality must suffuse the fabric of the cosmos itself; for otherwise it would always be possible to repartition and locate the origin of purpose in some other part.

Checkland distinguishes between 'purposive', whose meaning is the neutral serving-a-purpose, and 'purposeful', whose meaning refers to conscious intent-based action.

Teleology is behavior that fufills a conscious, goal-directed purpose. Teleonomy is behavior which can be described as if it had fufilled a purpose, i.e., when the goal is only apparent to an observer, but not explicitly conscious to an actor. (Checkland, 1988, pg. 75) I think there are a lot of problems with the way that Checkland conceptualizes these as being completely distinct; *a human can have a teleological purpose but an animal can't, it can only have an apparent teleonomical purpose. There must be a chaotic transition zone between the two - a kind of quasi-teleological purpose in which an actor is compelled to adopt an explicit purpose in order to retain membership as part of a larger, emergent structure.* (cf. Janis's Groupthink hypothesis.)

This seems to make sense within the context of the decision theory I'm developing. (cf. Hume; Schein; Gellatly and Zarate pg. 144; William James)

1. At the deepest level, human beings are motivated by desires, especially hedonic desires. Volitional desires are weak motivators and difficult to sustain for any length of time.
2. Humans also require three conditions to be met before they will take action:
    a. Disconfirmation of the status quo.
    b. Vision of a better state of affairs.
    c. A plan for getting from the status quo to this desired future state.
3. If these conditions are not met, freedom of action will be constrained and people will acquiese to the status quo.

The important point here is not that people "can't" take action; it is that they "won't" take action, at least not sustained action. In the absense of these preconditions any action would be motivated by volitional desires, which cannot be sustained over the long run. They are inhibited from any other possibility; they "just can't help themselves." Thus, these conditions provide the generating pattern by which (for humans, at least) the teleological purpose of individuals gives way to a quasi-teleological state within which the freedom of action of human actors is so constrained as to no longer exist in any practical sense. The most striking example of this is war: in wartime an army, and to a lesser extent a nation, can also be said to actually have quasi-teleological rather than teleonomical purpose, ***for as long as the individual actors are so constrained in their freedom of action that no other choice remains open to them****. And if the individual actor's freedom of action is ever permanently lost, in the sense that the actor can no longer survive outside of that web of constraints, then the transition process will be complete: the capacity for teleological purpose will have graduated to the next meta-level, and the process begins again. So are cells in turn comprised of their own individual components (e.g., mitachondria; and even further, DNA) which long ago yielded up their independence and freedom of action.*

"We" arose from our cells banding together in common defense...and just as the ant colony or the beehive acts as a superorganism, so too we may ultimately merge into human hives. Assuming we survive that long...

See also the memos on Temes and Memes; Autogenesis; Deal-breakers.

[05/02/07] See today's entry in the Procrastination memo. It looks like there are actually four conditions which must be met: (Schein; Gellatly and Zarate pg. 144; William James)

a. Disconfirm the status quo.

b. Develop a vision of a better state of affairs.

c. Develop a plan for getting from the status quo to this desired future state.

d. Having sufficient emotional desire to carry through with the plan.

This fourth item is distinct from the three articulated by Schein etc. The first three are cognitive. The fourth is affective; and without it nothing will happen. (Of course, you could also argue that it's related to disconfirming the status quo -- said disconfirmation has to activate the emotions somehow. So is it really so different?)

M.38. In vivo idioms

[03/08/07] Since I haven't had much luck finding a dictionary of idioms that specifically calls out decision making idioms and colloquisms, I've decided to begin my own.

- The catch
- The rub
- The kicker
- A deal breaker
- A show stopper
- The fly in the ointment
- Paying the piper
- The long pole in the tent
- A wash
- A two-fer
- To sweeten the deal
- A perk
- A bonus
- The clincher
- A killer application
- A throwaway decision
- To seal the deal
- To close the deal
- No choice
- No brainer
- Keeping my fingers crossed
- Buyer's remorse
- Taking a wooden nickel

[03/10/07]

- Sleep on it (#33)
- Just do it (#10)

[03/12/07]

- Play it by ear (#33)
- Toy with the idea (#33)

[04/20/07]

- On a kick (#25)

M.39. Is regret the inverse of dominance structuring?

[07/19/06] In thinking about what #10 says here, I'm struck by how regret seems in many ways to be the inverse of dominance structuring. Regret is kicking yourself over a decision that didn't go your way, based on factors that you don't fully control; dominance structuring is patting yourself on the back about a decision that did go your way, based on factors that you don't fully control.

I think the desire to avoid regret is a powerful motivator. *People pay a lot more attention to negative information than positive information* (I think this is from Rosen's Anatomy of Buzz, but for the life of me I can't find it now, even though I've combed through that book very carefully. Could it be from Cialdini's The Psychology of Influence? Or some other book I was reading at the time?)

[07/21/06] *Is there a feedback loop between framing, regret, and dominance structuring?* Framing causes regret; regret is uncomfortable. Dominance structuring, on the other hand, relieves anxiety and helps the decision maker feel better about the outcome. It is analogous to spin (see Deetz) in that DS neutralizes violations of dominance in an outcome, whereas spin emphasizes the positive aspects of an outcome. On thinking about it, they're more than just analogous -- *DS and spin are closely related, and may in fact be two aspects of the same phenomena.* Spin is a framing technique -- and by extension, so is dominance structuring. So DS can be seen as a technique for reframing to reduce or offset the discomfort of regret and erect a psychological defense.

[07/24/06] For a review article discussing *"negativity bias"* (people paying more attention to negative information) see Kanouse, D. E. & Hanson, L. R. (1972), cited in Kottonau (2000). Kottonau also cites an interesting article on *"status quo bias"* in Samuelson, W. & Zeckhauser, R. (1988).

[07/26/06] #10 finesses this issue (in 14:99) by *"leaning into" the problem* of riding in the rain, turning it into a liberating rite of passage. In (14:103) he has used dominance structuring to work out a way of framing the issues so that no matter what the outcome is, he has a dominant outcome and therefore doesn't have to experience regret.

Regret, by definition, occurs when people compare the quality of their decisions to what might have happened if they'd made a different choice (Plous, 1993, pg. 101-102; Dunning and Parpal, 1989). Dominant options are equal or superior to their alternatives over all need present in the decision frame. So, if a choice dominates all of its alternatives, there is no possibility of regretting the outcome; by definition you've made the best choice, no matter what happens.

See also Reason-based Choice (Shafir, Simonson and Tversky, 1993).

[07/28/06] #4 provides another example of reframing a disadvantage into a challenge in (17:59). "Well, there's sort of a challenge to it. 'How many groceries can I get home on the bike? What time can I haul into work?" This same theme appears again in (17:62).

M.40. "It was almost like they had a curfew"

[07/18/06] #10 has a great in-vivo quote here: "It was almost like they had a curfew or something, you know - like they weren't an adult, a mature human being who could do whatever they wanted."

I think he puts his finger squarely on self-image issues surrounding bus transit that are hard to articulate, but definitely present. *Being dependent on the bus to get around can be a rather like when your parents had to ferry you around town when you weren't old enough to drive -- and for many people there may be painful subconscious feelings about that awkward adolescent period when the other kids teased you about still being dependent on Mommy to get around.*

When the bus service is too restricted, there's more at stake than simple accessibility and availability. It strikes at the heart of what it means to be an independently functioning and self-confident adult.

M.41. Latent Needs

[08/17/06] Since the association between needs and technologies is one-way in the direction of technologies, this business of casting about to try and find some use for a technology requires a target need. There could be a modeling use for a "latent" need, as a kind of unanchored, unspecified "stub" need which will later be displaced by a real need -- if any.

M.42. Learning and unlearning

[05/15/07] At IAMOT 2007. Very interesting information in a talk by Roland Rust on feature fatigue (see Thompson, Hamilton and Rust, 2005). They conducted an experiment in which consumers were presented with a choice of two video players (visual basic mockups) and ask them to choose which they preferred: the simple versionl, or the complex one.

- *Both experts and nonexperts responded similarly, with no significant differences detected. (This would seem to correspond to the 'etic' dimension, with superior knowledge and theories but no actual insider experience.)*
- *However, there was a significant difference observed between experienced and nonexperienced users. The inexperienced users -- expert and nonexpert alike -- tended to prefer the feature rich version. However, the experienced users strongly preferred the simpler version. Shifts were observed in the weights accorded to usability and capability.*

[05/16/07] At IAMOT 2007. How, and under what circumstances, do people unlearn? If, as Heraclitas said, you can never step in the same river twice, then how is unlearning possible (except for amnesiacs)? The implication is that, ***once temors and momors are formed, they can never be broken -- only their state can change.*** There is no destructor, but they can be set aside or 'bracketed' in a process akin to 'putting your religion in your back pocket' -- ***making a conscious effort to exclude it from the decision frame.***

M.43. Making the best use of your time

[07/19/06] It seems to be a consistent theme that the ability to make good use of the time spent on public transportation has a lot to do with whether people mind the fact that the bus (or MAX) takes longer.

- #1 likes taking the bus, because she can use the time to people-watch, grade papers, prepare her lesson plans, or take a nap.
- #3 prefers taking MAX to driving, even though it takes longer, because she'd rather be reading than driving.
- #5 doesn't like taking the bus because the commute is either too short to make use of (Sunset to Goose Hollow) or else it's a milk run (MAX thru the Beaverton corridor.)
- #10 likes taking the bus because it gives him the opportunity to read.

[07/31/06] In (17:76) #4 points up an altogether unexpected aspect to time utilization on the bus: there's a professional image issue lurking here. "Professionals read things on the bus/train."

[08/16/06] Here it is again in (20:23):

#6: For driving to work, it's too expensive.

B: To take your car?

#6: Oh yeah. I mean, the economic consideration is...well, *I don't know if I'd say even now that it's a primary motivation, because I don't like driving in.*

I just enjoy reading on the... I'm so used to that. I like that time that I take the MAX.

Significantly, *time utilization doesn't seem to be a factor in whether people are willing to try public transportation, but whether they are willing to continue to use it.* This points up the idea that adoption and rejection really are two different cognitive processes.

[08/17/06] Later, in (20:34):

B: How do you like to use your time when you're riding public transportation?

#6: Reading or sleeping. [Laughs]

B: Reading or sleeping?

#6: Yeah, unfortunately I burn the candle at both ends, often. I'm very often dozing. Or I read partly, to say the Hollywood stop, and then use the rest of the time for dozing or just relaxing.

B: *Is that something that you do because you've got to find some way to pass the time, or is it something you look forward to?*

#6: *I look forward to it.* Sometimes I won't do anything, I'll just sit and observe, just as an exercise. I'm an inveterate reader. I may read too much. So sometimes I just put it away and watch the passing landscape. But there's not a need to, not usually. Not on MAX. The bus, sometimes is tedious.

[08/23/06] *I'm beginning to think that the reason why this time utilization thing is important is because it ties into the Humean theory of motivation -- using one emotional desire to balance out a deficit in another area; just as riding a bike can be justified by the exercise you get, and the time it saves from having to otherwise make time to exercise.* This could be a potential predictor variable in whether people will continue (as opposed to discontinue.) How will this translate in the bike commuting case? I'd say that's going to depend on their original motivation for commuting. I suspect if it's just to save money, that may not be enough. (Why?) I would hypothesize that sticking with bike commuting during the cold and dark will require some other emotional motivation to be brought into play. I think this remark by #8 is particularly telling: (23:35)

B: When you look at the time you spend on bus travel, do you see it as being purely a necessity? Or is it something that you found ways to look forward to?

#8: *I find ways to look forward to it.* You get occasionally, different people on the bus. But it's worth it - it is a quiet time. Once you have kids, or just a busy life in general, it is a time when I can just kind of [relax]. That's 20 minutes of my day, or half an hour, so an hour probably total (unless you get on a really crowded bus where you're standing up, and you're packed in.) But generally I do look forward to it.

Of course, her response is conditioned by the fact that I specifically asked her if she "found" ways to look forward to it, so I need to be careful to watch how my own language can shape the responses I get. I wish I had drilled further down into *how* these informants discovered ways of utilizing their time, but I think it's a little late for that with this case.

[10/09/06] In (26:18) #14 describes MAX as personal "relaxation time" or "me time" which she contrasts with time spent driving the car. She can read, or listen to music or books on tape, or converse with fellow riders with whom she's struck up an acquaintence. The MAX ride takes her a little longer, but she prefers it because the quality of her time is better balanced with the "quantity" of time she has invested.

[10/13/06] #18 has some interesting things to say on this score in (32:43):

#18: *I'm really twittery... like, anxiety ridden. My bus journey has been kind of caught up with me trying to be more of a quiet person, trying to be more okay with not a lot going on, being more okay with that. And that butts right up against being on the bus along with nothing to do. So, every time I choose to be on the bus I'm choosing to actively deal with that thing that*

bothers me. So of course I'm not going to take it a ton, but it's not just the bus. It's the bus and what you do on the bus. I think for a lot of people it's like... it could feel like that is wasted time, or they feel like it bothers them and they don't know why. I think I'm one of those people.

And:

#18: It really bothers me, that time between when the bus is supposed to be there and it actually gets there. I'm like, 'Lets go! [claps hands] We've got things to do! I've got to get to work! I need to do some filing!' And I start running through all this crap I have to do.

B: So this makes you even more anxious?

#18: Yeah, because I need to start doing something so I can stop humming, you know?

B: So, it sounds like - if I can paraphrase - one of the reasons why you end up driving your car down here is because you feel like you have more control over the timing of it?

#18: Yeah.

M.44. Microcommunities

[03/02/06] Summarizing some of the factors that here seem to be important to the formation of "microcommunities" form on rail or bus:

- Trip duration
- Number of stops?
- Bus/train frequency
- Compartment size
- Number of compartments and relative ease of movement between compartments
- Concentration of passengers at embarkation points
- Regularity of use (regular time each day, vs. occasional use)
- Lack of mutual interdependency (cf. carpool)

[07/12/06] See today's entry in "bikes for commuting vs. bikes for recreation."

[07/26/06] #5's experiences track with what #10 says in (14:108). #10's bicycle adoption is purely functional. It is consistent with his self-image, but image drives the adoption rather than the converse.

[08/17/06] #6's experiences (20:39) track with everything I've seen so far: he has met and struck up conversations with people on the bus, but that hasn't extended to the formation of friendship ties, nor did it influence his decision to take the bus or even which bus to take. These social connections are too weak and fleeting to exert a significant constraint on the selection process, let alone adoption.

[10/09/06] Ditto with #14 (26:20). She struck up acquaintences with other women on the MAX, and sometimes chats with them, but has not moved on to form significant relationships with any of them.

[10/13/06] In (32:54) #18 gives a reminder of another important factor: the degree of homophily with the other riders ("the level of sketchyness" in her words.)

M.45. Modeling desires

[08/11/06] I think Irvine's taxonomy of desire (2006, pg. 60) which is in turn based on Hume's A Treatise of Human Nature (1739) provides a solid foundation for the inheritance model of needs and desires. While I will need to alter a few names from those found in Irvine's taxonomy for the purpose of object-oriented analysis, I will try to coin as few neologisms as possible.

A *Motive* is a conscious or unconscious drive which influences a person to act in a certain way. It is modeled as abstract base class and must have a unique name.

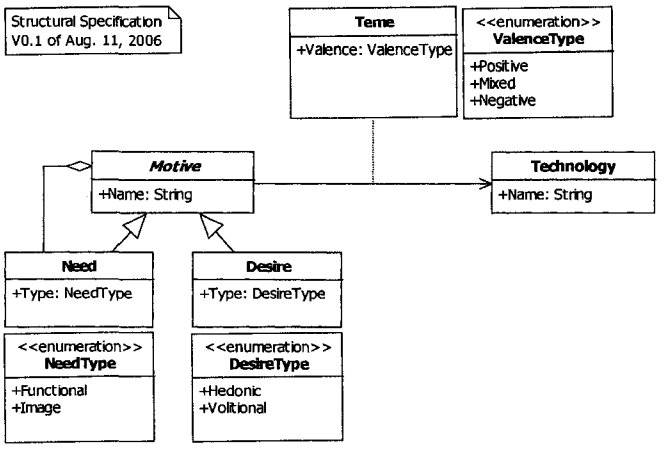
The two inheritors of the Motive base class are Desire and Need. A *Need* is a motive which is wanted for the sake of something else (i.e., it can be recursively decomposed into other motives.) A *Desire* is a motive which is pursued for its own sake (i.e., it is a primitive or terminal motive which cannot be further decomposed in terms of other motives.)

There are two types of desires: Hedonic and Volitional. *Hedonic* desires are emotional (affective) motives to experience good feelings or avoid bad feelings. *Volitional* desires are intellectual (cognitive) motives which arise from the will, 'just because'. Volitional desires are considered relatively poor motivators and it is hypothesized that they do not provide sufficient motivation for technology adoption. Hedonic desires, on the other hand, exert a very powerful influence on the adoption process. Even though it is hypothesized that volitional desires cannot motivate technology adoption, they will be represented in the model until such time that this hypothesis can be validated.

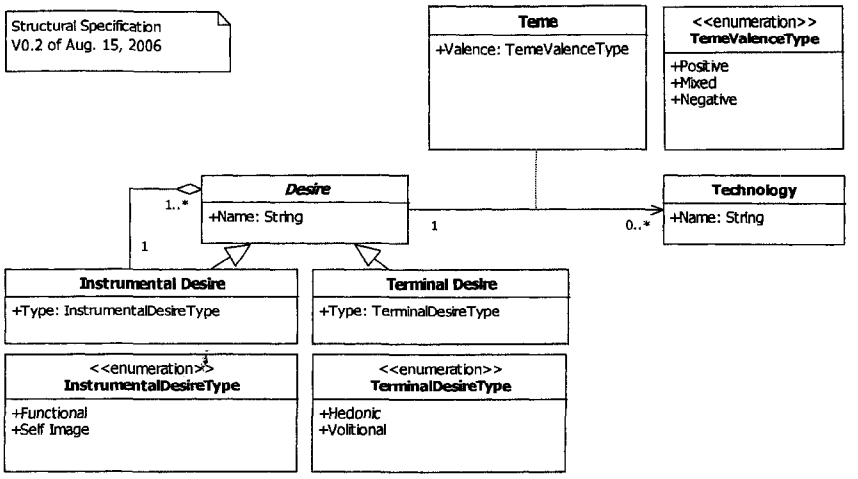
Needs are cognitive in nature, and come in two types: Functional and Image. *Functional* needs represent purely practical motives. *Self-image* needs pertain to social motives.

Instantiations of the Technology class must be identifiable by a unique name.

The *Teme* class models the directed association from motives to *Technology* instances which pertain to those motives. The valence of a teme characterizes whether the association is positive, mixed, or negative. The teme class will occupy a prominent role in the behavioral specification, since the formation of temes is the principal activity of the adoption process.



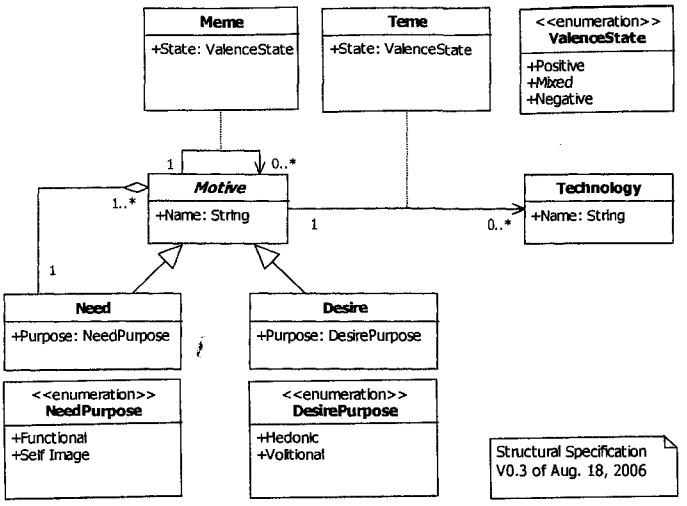
[08/15/06] I've gotten hold of Schroeder (2004), and after some struggles I've decided to try to adopt their nomenclature as closely as possible since some of these terms are already in use in the philosophy of mind literature. I don't necessarily like them, but on the whole I think it's better to try and follow their lead rather than make up new names which might lead to confusion.



[08/18/06] Okay, I've been looking at this new nomenclature for a couple of days, and it's just too wordy to be workable. I've gotten hold of Frankfurt (1988) and discovered that this nomenclature isn't as standard as I had assumed. I've decided to go back to my original scheme based on Motive as the base class; after thinking carefully about it, I believe that 'Motive' actually is the right word that captures the essence of what I'm trying to get at here.

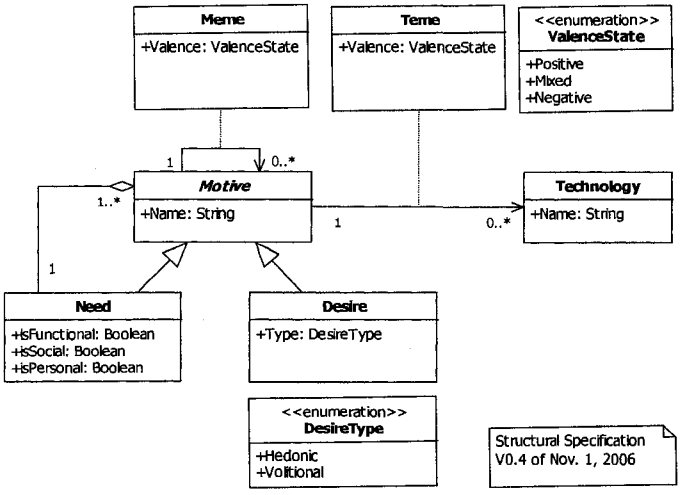
It has also occured to me that I need an association class which governs the links in a motive chain, and that not all links should be of the "I need X because I need Y" type. It is just as important to represent "Z will prevent me from accomplishing Y" type. For the time being I'll call that association a Meme, although I'll probably get some pushback on that. At the moment I think it is the correct term, however. In my scheme, a *Meme* is an association which acts as the "glue" or *causalative link* which holds aggregations of motives together. Like temes, memes have a valence. Due to hierarchical decomposition, it is possible for high-level motives (the classical, Dawkins-style view of memes) to be decomposed (one might say 'deconstructed' except that this invites confusion with object-oriented software term 'destructor') into constituent submotives. So far, the only difference between a Meme and a Teme is that the former describes associations between motives, and the latter describes associations between motives and technologies. However, I expect more differences to emerge as I proceed.

It is important to stress that a Meme does not describe a causal relationship between motives A -> B. Rather, a Meme describes a causalation relationship which has been inferred to exist between motives A -> B. Furthermore, this is a directional association; it may or may not be the case that there is also an association between B -> A. (Can a Technology ever be the source of a causalative association??? I suppose people do blame television for a lot of social ills...)



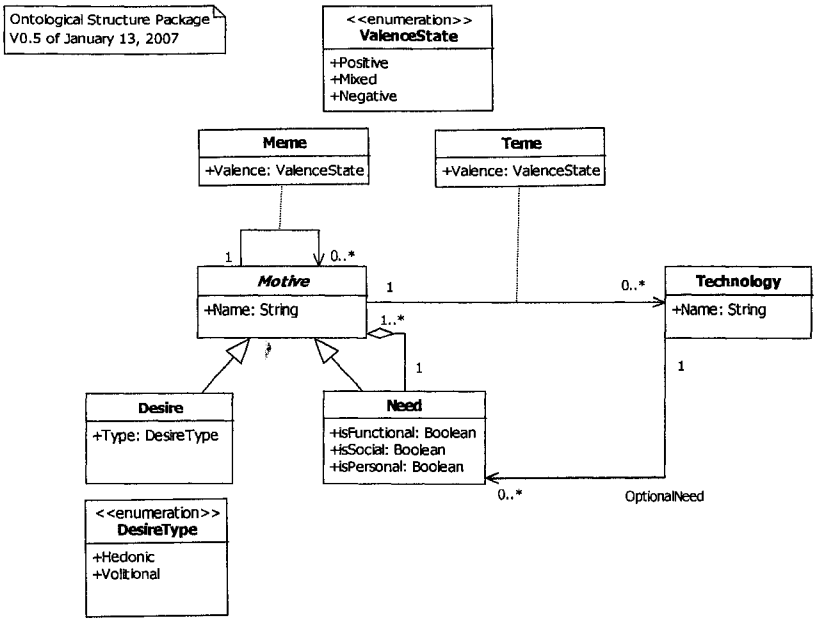
[08/20/06] Perhaps that should be "attributional link" rather than "causalational link". Causalation is a subset of attribution theory.

[11/01/06] Modified the NeedPurpose enumeration to reflect three dimensions of adoption, rather than the earlier two. Changed need type from enumerations to booleans. A 'mixed' valence on a teme or meme is a strong indication that the motive needs to be unpacked or decomposed to determine the nature of the conflict.

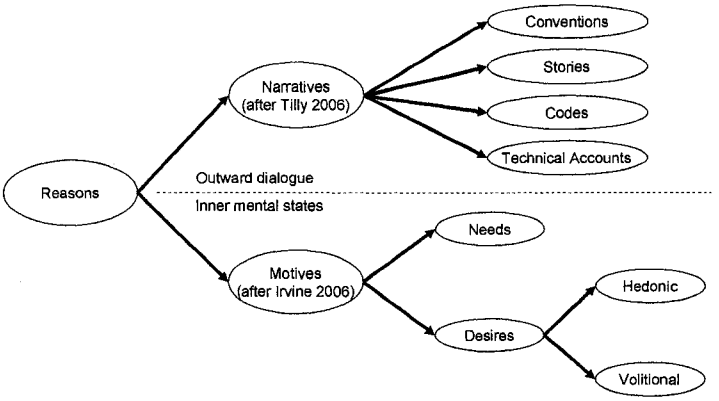


[11/18/06] The recursive nature of motive chains is suggested by in vivo expressions such as *'getting to the bottom of'* an issue. What is the nature of such a 'bottom'? Is it a configuration of motives that is sufficient and requires no further decomposition?

[01/13/07] Added a link to make it explicit that needs can be decomposed in terms of other motives. Added a link from technology to need to make the optional need connection explicit.



[03/14/07] I've been reading 'Why' by Charles Tilly. It seems to me his approach is complementary to my own, although our terminology is slightly different. A *conceptual map* of reasons might include:



It's a kind of inheritance diagram. Reasons are explanations of why we do what we do. There are two kinds of reasons. Motives are inward-directed reasons which represent inner mental states. Narratives are outward-directed representations of an event or a series of events (Tilly 2006, pg. 64; Abbott 2002, pg. 12). Narratives repair and maintain important social relationships. To the extent that narratives become internalized, they also serve to maintain and repair self-image. The audience for internalized narratives is the narrative self, the continual dialogue we maintain with ourselves and which is vital to our ability to be-in-the-world (Sacks, 1970).

Narratives are outside the scope of my theoretical framework, but it is still important to understand them because all evidence of inner states (motives) is expressed or filtered in terms of conventions, stories, codes and technical accounts (per Tilly 2006.) Inner states cannot be measured directly (Tilly 2006, pg. x-xi) Thus, narratives have epistemological relevance, just as motives have ontological relevance. (narratives are meant to include condemnations as well.)

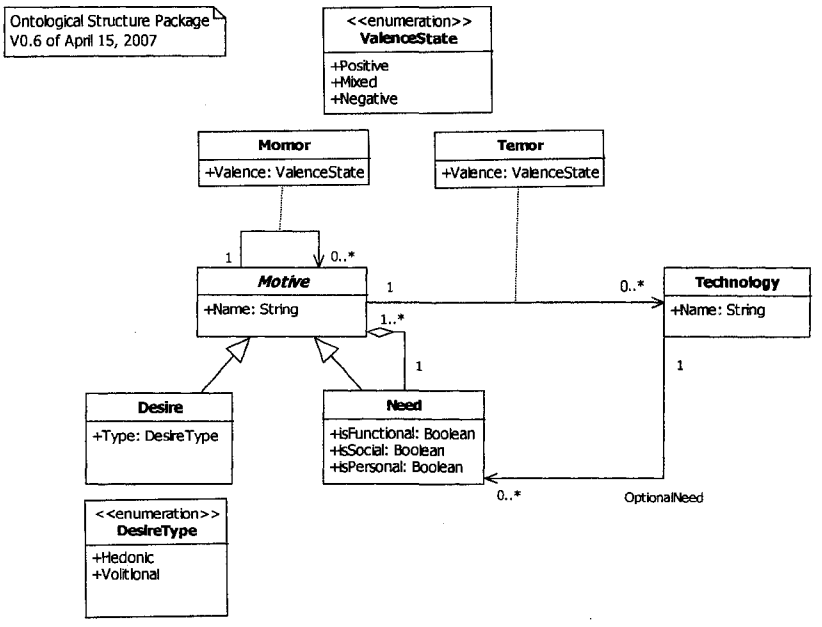
This crops up in explanations of why people don't like to ride the bus. An informant who wishes to avoid riding a "smelly bus" full of "sketchy people" is employing a narrative euphemism to avoid articulating inner motives (e.g., avoiding association with

marginalized outgroups; fear of violence; etc.) Such avoidance may occur due to social reasons (e.g., fear of censure from others) or for personal reasons (fear of self-censure, dissonance and internal conflict.) Cognitive dissonance works by employing 'strategic ambiguity' -- avoiding matching up narratives with motives. "It works better if you don't think too much about it." Too much introspection can jeopardize one's ability to act in the world.

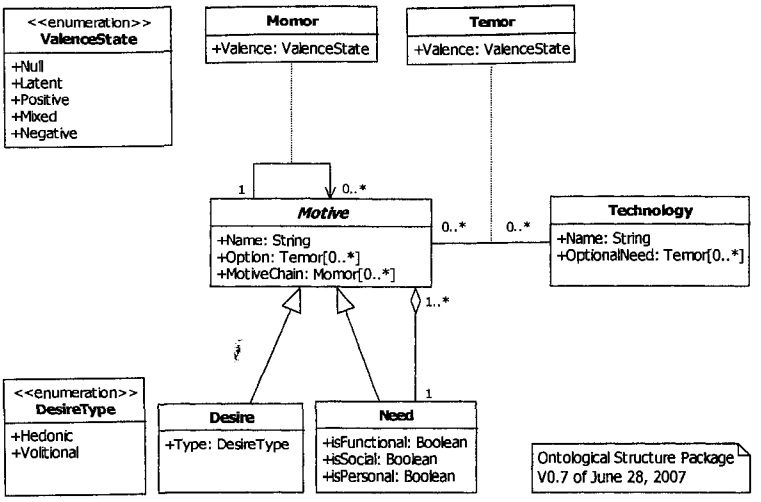
As one marketer told me, consumers will not tell you the "real reasons" (i.e., motives) why they do what they do. Several interviewing guides recommend avoiding direct 'why' questions for this reason -- it puts people on the spot. narratives are not necessarily offered for the purpose of concealing motives, either from others or from themselves. In most cases people genuinely do not understand their own motives. Neuropsychology and evolutionary psychology suggest that the narrative self is not the only concept of "self" we have, nor is it located in a single place in the brain, nor does the narrative self always have the final word on why we do what we do. In fact the narrative self seems to function more like a narrative generator -- an internal apologist, if you will. In any case the narrative self -- our inner dialogue or voice -- does not "think" in terms of motives. It thinks in terms of narratives. Motives are a more holistic expression of why we do what we do, and take into account not just the narrative self but the other levels of self-image as well.

Narratives are not simply public motives. They are structured differently. Every single person in the winter bikes case commented on the issues list that a) it was a thorough synopsis of their case, and b) they'd ever heard it put quite that way before, stripped of stories/conventions/codes/technical accounts and simply presented as a pure chronology. People just don't think in those terms.

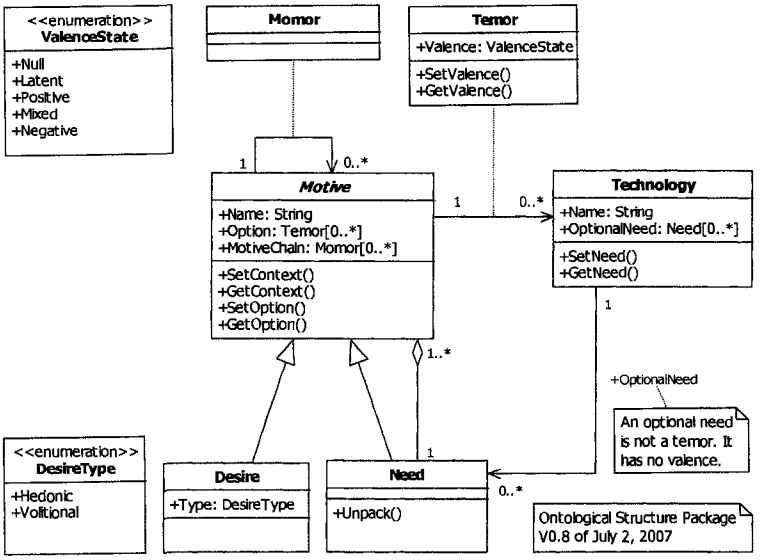
[04/15/07] Minor nomenclature change to expunge the "meme" baggage. See today's entry in the Temes and Momors memo.



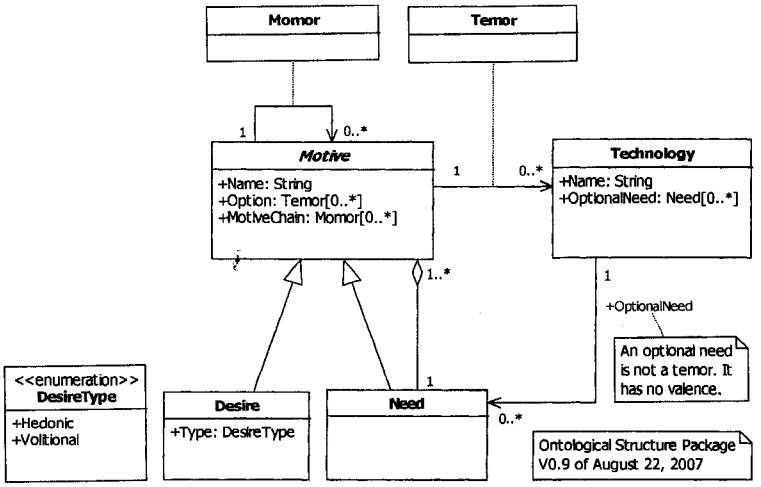
[06/28/07] Changed the ValenceState enumeration to reflect the latest state of the behavioral analysis. Added some attributes to the classes to reflect the event definitions from the behavioral analysis.



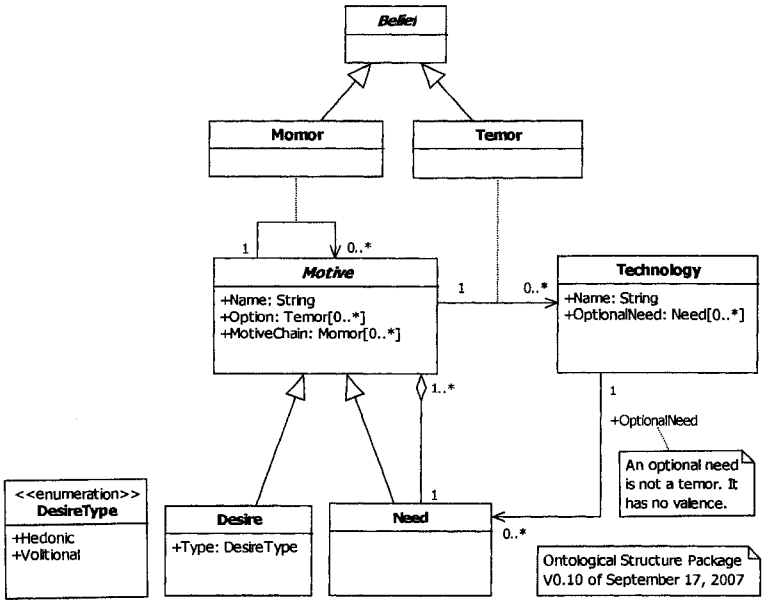
[07/02/07] Added methods to update the class attributes. Clarified that an optional need is not a temor, because it has no valence. NOTE: see the "Latent Needs" memo of 8/17/06!



[08/22/07] Reworked valence enumeration to reflect results of behavioral analysis. I decided to suppress the operations portion of the class diagram because it seemed to add clutter without clarity; this is a conceptual rather than an operational model.



[09/17/07] Added a virtual base class to make it more explicit that temors and momors types of belief.



M.46. Modeling mixed transit modes

[7/10/06] Mode mixing seems to be a common theme, as here when #5 indicates that he wanted to take his bike on the MAX. It's a strategy for solving conflicts among individual transportation modes. But does the resulting adoption or rejection apply to the constituent modes, or to the mixed-mode solution at the aggregate level?

It seems clear to me that adoption needs to be modeled as a multilevel, hierarchial phenomena. At the top level is the basic question: 'Do I have a solution to this need?' And that solution may be an aggregate of solutions to individual subproblems. This

suggests something about how to develop the structural model, that the top level structure (or category, in qualitative terms) is an object with subparts (subdecisions.)

I have several modeling questions and design choices to resolve here. Should I model the main object as an aggregation of smaller decisions (subparts have independent existence) or a composition of smaller decisions (subparts do not have independent existence)? Are decisions always one or the other? I can envision some decisions which present rather specific problems to be solved, and the solutions to those problems do not carry over, as with the problem of figuring how to deal with the rain when you're commuting by bike. This suggests composition. On the other hand, some decision problems present subproblems that may be useful in other situations, as with the problem of getting to doctor's appointments etc. when you're commuting by bus (--> Flexcar.) This suggests aggregation. *Perhaps all subproblems should be modeled as aggregations, it's just that the solution to some subproblems are more generalizable than others.*

Another issue pertains to the question of *knowing when to explode and collapse a decision* into its constituent subdecisions. Unlike rational decision theory, which does not consider the cost of mental resources associated with this, *I believe that there is a cognitive cost associated with exploding a decision into its constituent parts and keeping that decision process open pending a solution. This resource cost ceases when the decision collapses, explaining why people are uncomfortable with ambiguity; it might also explain why procrastination occurs. Procrastination is a form of collapsing; it reduces the ongoing mental cost of the decision, since you know what needs to be done, but it's a quasi-stable state. It does not reduce the cost to zero, and it requires an additional cost before it may be reduced to zero, but for the moment it is stable -- a local minimum. Somehow the model must be able to take the cost of cognition into account.*

I also detect some concurrency going on within the behavioral view. Collapsing the main state is contingent on collapsing all of the substates (collapsing does not necessarily involve finding an acceptable solution; it may also include finding a workaround which is less than satisfactory.)

[07/13/06] With respect to collapsing, take another look at Montgomery's dominance structuring paper. It explicitly discusses collapsing along with deemphasis, cancellation, and bolstering as mechanisms for resolving the needs conflict and condensing it into a single category.

[10/13/06] In looking at #14's comments in (26:47) it seems likely that trip chaining is the 'orthogonal counterpart' to mixed transportation modes. Just as one can combine several different modes to make a single trip, one can also combine several trips into one with a single transportation mode.

M.47. Needs vs. advantages

[07/17/06] This diagram addressing the survey question "Why do you bike to school?" is misleading. Based on the interviews with my informants, *the top justifications given here -- such as "biking is fun", "reduced air pollution" -- describe some of the advantages of cycling, but they seem to emphasize the perks rather than the primary needs which really drove the decision.* I think this is something of major importance: the advantages of cycling are not the same thing as the primary need which drove the decision. The primary needs reported by most of my informants, such as "saves money", "parking is costly", "parking is hard to find" are not rated at the top of the list and are in some cases rated rather low. Note also the overlap between "saves money" and "parking is costly" (of course, cars are expensive in ways other than parking fees.)

By comparison, look at the reasons given in the 2004 survey of faculty and staff: "saves money" and "parking is costly" are right at the top of the list.

A couple of possibilities here. 1) This survey is dominated by student respondents and thus reflects a different set of needs, issues, and priorities than faculty/staff. 2) The

respondents could be giving answers which reflect dominance structuring and identity formation rather than decision making. 3) My informants are not representative.

These data hint that *we should be careful in attributing too much causal explanation to factors simply because they are more commonly reported in a survey. These factors may be more commonly reported because they are popular, justifiable, defensible, salient, or available rather than causal. It is widely understood in consumer psychology that you may not be able to get at the underlying causal justification through surveys.*

Needs are different from advantages. A advantage may not be needed (a perk). A need may not be a desire (e.g., vitamins -- although this changes the perspective from "What I need" to "What you need"). Could a need be considered a disadvantage, such as addictive behavior?

M.48. "No brainer" decisions

[03/01/06] #3 remarks that central location made for an easier decision. What makes a decision 'hard' or 'easy'? Are easy decisions those whose conflicts are more readily reconciled (i.e., it is possible to structure a dominant outcome?) Does this imply something about the nature of the decision making process?

[07/24/06] #10 discusses this in terms of making a spot decision about whether to continue with his previously decided plan to purchase the monthly pass in terms of new, unfavorable information. He said that at the time it wasn't obviously bad on its face -- it wasn't a *deal-breaker*, in other words -- and this made it more difficult to make a decision. *Seems like this is related to dominance; a dominant decision is a no-brainer decision.*

[10/09/06] #14 also relates a quick decision process in (26:16). She was already dissatisfied with the current state of affairs. From 26:17:

> #14: Driving the Banfield was an awful mess all the time, and I would see the MAX trains going by, so when the Flexpass came up I thought 'I'm just going to do it.' Some people said to me 'Don't you want to try it first?' 'No, I'm just going to do it...*just do it!*'

This seems to behave like a *guard condition.* The 'just do it' remark is also interesting and echoes #10's quote from (14:81) and (14:117).

In grounded theory terms, "no brainer" decisions seem to stake out one end of a dimension, with the opposite end being "difficult" decisions and procrastination marking the middle. Or perhaps "no brainer" stands in opposition to procrastination? Maybe there is more than one dimension present here: the degree of thought required (no brainer vs. difficult) and the degree of emotional motivation present (no brainer vs. procrastination).

[11/10/06] Switching terminology from "killer application" to "clincher" from this point forward in the analysis.

[01/03/07] Jason mentioned another interesting variation on this, the "throwaway decision" -- a decision made so quickly and so casually that it isn't given serious consideration. It can be thought of as a variant on a "no brainer" decision, except with little explicit consideration.

M.49. Norm theory and framing

[11/20/06] There's something here I didn't catch the first time through coding, and it was only when I was putting together the decision diagram that I noticed it: #17 didn't say anything about the cost of the motor pool when I first asked him how satisfied he was. *This issue entered the decision frame* only after I mentioned that Flexcar was essentially free for trips during the work day.

I can't shake the feeling that there's something fundamentally important in this. When asked which factors were important to his decision about a single technology option

taken in isolation (in this case Flexcar), #17 replied that he didn't think they were accessible to his location. But when faced with a comparison between two choices, *new issues entered the decision frame. This suggests certain similarities to norm theory (Kahneman and Miller). We judge things in comparison to what we consider to be normal. Thus, needs can enter the decision frame based on comparisons to selection substitutes.*

This occured to me as I was walking home with my groceries, thinking to myself that when I was really in a hurry and needed to be sure of getting somewhere on time, my bike is a better bet than the bus (which can experience long, unpredictable delays.) But before I began riding my bike, that wasn't something that I normally disliked about the bus. It was only when a realistic alternative to the status quo became available that new issues entered my decision frame.

This also calls to mind *Schein's three conditions for change*: disconfirming the status quo, having a better option available, and a realistic plan for implementing that option. *These conditions are linked on a deeper level than I previously suspected. It is precisely the availability of a substitute that causes new needs to be admitted to the decision frame which tend to disconfirm the status quo.* There's a possible mechanism at work here which explains why Schein's formula holds true in so many situations.

M.50. Not on the radar

[04/17/06] This whole passage at 11:102 about bicycles not being 'on the radar' is interesting in terms of what it says about the framing process. It suggests something about the importance of imitation to framing -- structural equivalence, or functional equivalence, etc. If you see yourself as a professional, you frame your transportation choices accordingly. If others commute by car, or MAX, or bus, then those are your options. But if one has a positive view of bicycles from childhood, perhaps it only takes one or two examples of near-peers using them to commute before you think they may be a serious option for yourself...

Most significantly, #4 refers to this as "a threshold you break." This suggests that framing can be a revelation, a sudden insight, a discontinuous change, a gestalt -- like the opening chords to Beethoven's 5th. The 'ah ha!' feeling.

[7/7/06] It also seems to hint at something about the difference between a value-centered adoption and the construction of a technology-centered identity, but I'm not quite sure yet what it might be.

[7/10/06] This business of adopting the norms of near-peers reminds me of Norm Theory (Kahneman and Miller). Each stimulus recruits its own alternatives.

[7/11/06] This is interesting; #5 confirms what #4 was saying, and even uses the same in vivo phrase "not on the radar" to describe it. Even more significant, #5 says it's highly resistant to advocacy: "I've had no success in convincing them it's rational or getting them to change their minds."

[07/24/06] This tracks for #10 too, in quote 14:85:

B: Had it occurred to you?

#10: It had occurred to me as like a...it had somewhat occurred to me, but I hadn't actually done it. I had never biked from where I lived to downtown. And all of my past biking experiences were much more leisure-oriented, except for Eugene.

So it appears that an important part of recognizing bicycles as a legitimate candidate for commuting is to be able to visualize yourself in that situation...a combination of the vision and 'having a plan for getting there' part of Schein's formula. Part of the 'threshold you break' is just being able to visualize yourself in that situation -- which in the case of bikes, I hypothesize involves dread risk (fear of getting clobbered by cars.)

[08/17/06] In (20:43) #6 gives a *different example of something being 'not on the radar'* (i.e., a latent need.) In the course of discussing his excitement over purchasing a new car, he says:

B: You don't use either [car] to commute down to campus?

#6: Uh, I will, probably, from time to time, as I did last week. And one time this week, depending on if I have to get down here to some appointment. Like yesterday, I had a dental appointment. So the bus line...the bus that I take gets me here a little later than the 8 o'clock that I'm supposed to be here, but we're pretty liberal about that. So it's work. But if I have to be here, like for an 8 o'clock appointment, then I'll Park and Ride. So I could forsee my doing that in future, from time to time, to use the old egg-beater and drive to Gateway station and park, and take the train. It might be a coming thing.

Even though we discussed Flexcar earlier in the interview, it never occurs to #6 that Flexcar might be a better option for getting to a dental appointment (assuming that appointment is downtown, which may be a big assumption.) But certainly Flexcar is not on his radar, despite the fact that this application is one of the ones Flexcar has been pushing the hardest. I guess #6 can't visualize using Flexcar for that purpose...he only began thinking about it in the context of an emergency ride home, and perhaps that's the only association he's formed for it (an option which was briefly considered at one time, but ultimately discarded.) However, in (20:45) #6 seems to imply that when he has an appointment he's only talking about driving to the Park and Ride -- so maybe the appointment he's trying to catch is out past Gateway. Unfortunately, I didn't ask him about that...

[06/22/07] See today's entry in bikes for commuting vs. bikes for recreation.

M.51. Perks

[03/01/06] For #3, Flexcar wasn't the driving consideration in the decision to purchase PP+; TriMet access was. Flexcar is a "perk." But what is a perk?

#1 says that the initial reason she bought the annual pass was the cost savings; yet over time this was restructured such that convenience was the main advantage.

Perhaps today's perk is tomorrow's killer application?

#1 adds that Flexcar was a perk for her as well. Like #3, she had already decided to purchase the annual pass. Flexcar is one of the perks; thus, it seems that a perk really isn't a need in the strict sense; by definition, a perk is an advantage that you don't really "need". An unneeded need, as it were. But over time one can really come to depend on unnecessary comforts...cell phones spring to mind.

[04/18/06] During the April 18 conversation with Eban Saling this issue came up again -- that PSU didn't intend for Flexcar to be a "perk" or a "fringe benefit" but has a specific objective (reducing competition for parking spaces.)

[08/08/06] I think #4 gives an important clue in (17:34) as to what a perk is, and what its function is in the adoption process. In discussing the real-time tracking system offered by TriMet, it's clear that his adoption of the bus wasn't predicated on the availability of this perk. However, the inability to control the timing of his trips thru TriMet and the associated uncertainty caused discomfort which is linked to bus regret. The tracking system helps alleviate that uncertainty and reduce the potential for bus regret. In turn, this improves the ability to construct a dominance structure around bus adoption. Thus, the value of this perk is to cement adoption, rather than trigger it. ***Perks are needs which pertain to dominance structuring. Killer applications, on the other hand, are needs which pertain to the formation of initial interest and a decision to proceed with the adoption.*** *Perks influence the quality of adoption and may prevent substitution. Killer applications influence whether the adoption occurs in the first place.*

[08/24/06] ***See today's entry in the Procrastination memo for a very important and unexpected connection between perks and procrastination.*** I think this explains why perks may influence the quality of adoption, but can't by themselves drive the adoption process.

[11/10/06] I'm switching from "killer application" to "clincher" from this point forward in the analysis.

M.52. Primary needs, perks, and clinchers

[3/15/06] A *primary need* is an important application. It is the basis on which the decision outcome is rendered. It is hypothesized that people will always have a reason for making the decisions they do (cf. reason-based choice) but that they may not always be consciously aware of what these reasons are (tacit or latent needs, vs. explicit or consciously acknowledged needs.)

A *perk* is a *secondary need* which conveys some relatively minor advantage. It is hypothesized that a perk can never form the basis for the decision outcome. Alternatively, decisions based solely on perks are relatively weakly held and easily reversed.

There are two primary psychological uses for perks. First, a perk can be used as a public justification of a decision outcome if the primary need would encur socially disapproval, and thus requires concealment. Thus, a perk may serve as a device for concealing one's true motives in reaching a decision. Because functional needs may be easier to justify than social needs, it is further hypothesized that perks may tend to be functional in nature, and that functional perks are often used to conceal primary social needs or protect them from social attack.

Second, a perk can be used to help construct a dominance structure -- the "patting yourself on the back" feeling, which is one way of bolstering the ego. It is hypothesized that perks will tend to be discovered during the differentiation and consolidation phase, after the primary need has been identified and the decision has been made to use the candidate. A perk may be used in this manner to reinforce and bolster a decision; after a committment has been made to a candidate it is hypothesized that the importance of perks will be inflated in comparison to their importance before the point of committment.

A *"killer application"* is the primary need which can only be satisfied by a unique technology candidate. Identification of a killer application sets up a dominance condition favoring the candidate to the exclusion of all rival substitutes.

[11/10/06] I'm replacing the term "killer application" with "clincher" from this point forward throughout the analysis, but I'll leave intact those places I've referred to it in the past as part of the history of how I got to this point. Retitled this memo from the old title, "Primary needs, perks, and killer applications"

M.53. Primary/perk vs. functional/social dimensions

[03/15/06] The primary/perk dimension overlaps with functional/social dimension to a certain extent. I hypothesize that the causal relationship is from functional/social -> to primary/perk, in other words the type of need -- functional or social -- helps determine whether a need is primary or a perk. But how, exactly, does this work? Under most circumstances it seems like functional needs are in the drivers seat (primary) whereas social needs are often seen as perks (e.g., socializing).

But not always...

M.54. Procrastination

[5/19/06] I think there's more to procrastination than economic considerations. They're partly responsible, but I think even more to the point is the simple strategy of avoiding unnecessary mental effort. Many times problems take care of themselves after a while, or somebody else solves them for us, or they don't seem as important after all. Procrastination can be seen as a decision making strategy: we intend to do something, we just never get around to it. Thus, image issues are mollified (we meant to...) *But what cuts short procrastination? When do we decide it's time for action? Probably when there's some sort of deadline involved -- here is a clear-cut case in which a*

timeout or count becomes an important factor in the decision making process (e.g., "Sale ends Friday!") I also sense there's an important connection here to perks and 'killer applications' -- if the relative advantage is based on 'perks' then one might expect people will endlessly procrastinate due to the mental effort associated with trial use. On the other hand, a killer application together with a time limit should cut short procrastination and lead to an immediate trial use.

Something else that's interesting, too, is the parallel to shopping I alluded to in the interview with #8. I can window shop for hours without buying something; then when I finally find that one thing I really want, once I lay out the money it becomes much easier to buy other things, which perhaps I don't need as much. It's like wandering around at Powell's, browsing through interesting books, maybe taking them into the coffee shop, but ultimately returning them to the reshelf not because I didn't want them, but rather because I didn't want to bother with standing in line to pay for them. 'I'll buy them next trip' I would say to myself, and sometimes I would and sometimes I wouldn't. Once again, procrastination in action. As a followup I need to find some references to this in the consumer psychology literature to this phenomena -- I don't know what they call it, but I intend to find out. I'll hit the PSU library today after the dog and pony show.

[08/01/06] From my bicycle journal:

> It also occured to me that I'm procrastinating about making preparations for riding in the rain and the cold. I don't know why this is the case. Last weekend when we made the rounds at the bike shops I had the opportunity to price out some bike clothing, but I didn't want to spend any money...things are a little thin during the summer, and Adam's illness has tapped our funds. Nevertheless, there's something I can't quite put my finger on regarding the procrastination. I know what I want to do, and am fully resolved to do it, and yet I don't do it even when I've got the opportunity. It reminds me of what Jason told me about his grandfather's driving habits -- he would get stuck in traffic and they wait, and they wait, until it was almost too late -- then he would lurch violently forward, as if he was trapped by indecision until last-minute panic forced him to take action. Jason said that was something his dad used to rant about regarding Jason's grandfather (who was nearly blind and still driving.) I don't know if this was just a pithy rant or if there's really some kind of physiological basis to it, but it's interesting that *procrastination seems to require some kind of external event to force action; self-imposed timeouts or counts don't seem to work as well (maybe this is why I've seen so little evidence of them in the transcripts??] This is like the risk mitigation practices they teach in project management, that you should have some clearly defined criteria to put mitigation plans in effect and then regularly monitor whether those conditions have been met. Plous (1993, pg. 242) discusses a variety of behavioral traps in Ch. 21. Procrastination seems to fall within the purvue of what are called time delay traps -- momentary gratification (not expending the effort on thinking) clashes with long-term consequences (failure to take action.) Behavioral traps can also be used constructively. From Plous (1993, pg. 252): "For example, recovering alcoholics, ex-smokers, and dieters often 'screw their courage to the sticking place' by intentionally trapping themselves in healthful patterns of living. When entrapment is desired, decision makers should:*
>
> - *Avoid information about the costs of entrapment.*
> - *Refrain from setting limits or evaluation the costs of continuing.*
> - *Make a public declaration of commitment.*
> - *Compete with people who are striving toward the same goal."*
>
> [See also Brockner and Rubin (1985), cited in Plous.] What I think is interesting about this is that these guidelines suggest something about the causal mechanisms for procrastination. Just what that might be isn't clear to me yet, but the fact that my informants don't seem to be using time limits or counts to limit their decision process is probably saying something significant about the psychology of decision making.

[08/17/06] #6 touches on these issues in (20:30). Even though Flexcar is free, "I haven't looked into it...probably just being lazy about it, because it does sound like a good deal." He goes on to say "What was running through my mind, and what runs through my mind now, is that it's something that might be available to look into, but I'm not strongly motivated right now, for different personal reasons. I'm getting along pretty well. [...] [M]y needs perception for Flexcar has not expanded, in other words."

Based on the reading I've been doing over the past few days to develop the Structural Specification (Hume 1740; Irvine 2006; Schroeder 2004; Frankfurt 1988) I'm beginning to suspect that a lot of procrastination occurs because the emotions aren't engaged. It isn't just happening out of mental lazyness; people simply have a hard time developing any sort of motivation when the emotions aren't engaged, no matter how good the idea may sound on paper. This would explain why time limits seem to be involved, but not counts -- unless the adoption involved counting down to zero or some other absolute reference point. Relative counts are unlikely to provide the same degree of motivation.

#6 considered Flexcar only because he did experience that a sudden emotional need to get home in a hurry, and once the crisis had passed (with little chance of recurring in the future) his interest in Flexcar waned and disappeared. He cites an analogy in ((20:30): "It's like people who live in Oregon who may never have been to Mount Hood because it's so close. Mount Rainer, which I have not been...although I've been halfway across the world, but I've never been to...it's sort of like: it's there, I know it's there, so I don't feel the urgency." So where does the urgency come from for people who are visiting Oregon? From the fact that they have limited time on their vacation for sightseeing. Without the time limit, the emotional feeling of urgency dissapates, and so does the motivation.

Which brings up the interesting point, raised by #10 in (14:117) and (14:88): the way he cut short the procrastination was to just do it, to make a leap and give it a try. And where does THAT come from? Is there an emotional need lurking even here? Perhaps it's because uncertainty generates its own emotional distress, and thereby provides motivation for doing something, ANYTHING, just to not have to experience the discomfort of uncertainty anymore?

There's another interesting quote from #6 in (20:63):

> #6: The Flexcar, that could be...and *the thought about it economically, probably makes sense. But I don't...as I said before, I'm a little lazy about it.* I guess I have the sense, 'Well, that's a pretty good deal, I can look into it.'

Once again, here we have an instance where something makes sense intellectually, but because it doesn't engage the emotions there's no motivation to proceed. How long can procrastination last? Indefinitely, I would say...there's no obvious limitation on passive interest, at least until the Flexcar service folds or there is some other kind of prompting event that increases the emotional stakes.

The comment in (20:63) about *"that little [Honda] Element out there; it might be fun to drive"* is interesting and matches up with #1's evaluation of Flexcar (8:96): *"It might be something fun to do just to drive another car sometime, just for kicks."* It is as if both informants are saying: *I might be willing to try it if there were some chance for me to get something out of it emotionally.* But in both cases they're kind of grasping for straws in terms of a motivation, and they seem to be aware of it.

Maybe this is why the 'disconfirm the status quo' part of Schein's formulation is so critical. The disconfirmation raises the emotional stakes by heightening people's sense of alarm (about their own job security.)

[08/23/06] Oh ho, maybe there's something the Humean theory of motivation overlooks here. Perhaps one of the ways of overcoming procrastination is (initially) the sheer exercise of willpower to get past the status quo bias of doing nothing. Then, once the emotional interest develops in the task, it becomes self-sustaining. If that's the case, then volitional desires could actually plan an important role, if only to provide that extra get-off-your-duff impetus.

[08/24/06] In (23:66) #8 seems to suggest that part of the reason why she's procrastinating about Flexcar is that it's a perk rather than a killer application:

B: And now what is your thinking about it?

#8: Well, now there's not really...any of the reasons kind of keeping me...well, helping me procrastinate, which is cost, and thinking that I don't really need it that much, are sort of waived. Because, I mean, there are a few times when I think it would be convenient to have it.

"Would be convenient" is kind of a weak need, particularly since it provides only an occasional convenience and comes at some cost in terms of learning (and stress, but that comes later.) I hadn't suspected until now that there might be a connection between perks and procrastination, but it makes total sense from the standpoint of Humean motivation: *a perk is a need which does not by itself provide a strong enough emotional motivation to ensure action. Thus, if a technology can only offer a perk as an advantage, people will procrastinate because they lack enough emotional motivation to adopt.*

[08/28/06] In (23:69) #8 says,

#8: I think in this case, the inconvenience that we've been experiencing, and the cost along, is enough to *jolt me out of my slumbering state* here in terms of 'Oh, it's not that big a deal.'

And yet, based on her e-mail communication to me from last Thursday, she is still wavering. Evidently inconvenience and cost alone are NOT enough to jolt someone out of procrastination?

Then again, in (23:71), #8 describes it as a hump: *"Once you get past that hump, then it's usually quite easy."*

See today's memo entry for Timers and Counts for important notes about modeling procrastination as a guard condition.

[08/28/06] Another interesting exchange with #8 in (23:74):

B: Yeah, I'm reminded of when I go to the mall, and it's like... I can walk around the shopping mall for a couple of hours and not spend any money.

#8: Yeah.

B: You know? And once I've finally actually parted with some money at a shop, it becomes easier for me to spend money at that point.

#8: Right. Exactly.

B: I'm wondering if...is that a familiar feeling?

#8: I would say so, in this case.

B: And do you think that's kind of relevant here?

#8: Yeah, I would say so. And, seeing now that the shirt is not as expensive as you thought it was, maybe it's on sale now, and so you get it.

Perhaps Cialdini's book will have something to say about this...

[10/09/06] See today's entry for "no brainer" decisions. *One thing that's interesting about no brainer decisions is how action is taken immediately -- "just do it", as #10 and #14 describe it. Precisely the opposite of what happens with procrastination* -- and different from rejection, too. With rejection at least a decision is taken not to take any action. With procrastination a decision is taken to act, and yet that decision is not acted upon. It's like deciding to decide to act, rather than actually acting. It's like Dick Fairley's remark about "planning to plan" or that cartoon about the "planning sessions".

[10/13/06] In (32:57) #18 describes a negotiating process to increase emotional incentives to overcome procrastination:

#18: I think in general a lot of times when you're procrastinating, you're procrastinating because you don't want to, but you know you should. So, while I know I *should*, since I don't really enjoy it, it's kind of like...'You should eat your peas.' And I don't friggin' want no peas. So part of it is like, 'Well, here's cheese sauce!' ... 'Well, here's exciting music to listen

to while you have peas and cheese sauce!' You know, trying to put those things together, like literally trying to find in my downstairs, a CD player. Trying to put some stuff together, put it on reserve, to get books on tape. Trying to get used to making my coffee early in the morning so I can drink it on the way. Putting all these things in place.

[02/25/07] #36 also touches on overcoming procrastination in (33:00-34:00) and provides an ***important disconfirming case***:

#36: I think for me it was like facing a fear, because I was really afraid to do this. Just saying, 'Come on! You can do it!' and being willing to deal with whatever was going to happen - hopefully I wasn't going to be dead by the end of the day - but whatever was going to be an obstacle, I could figure out. I am the one leaving at 6:30 in the morning to get going, by myself. ***I just did it.***

This "just do it" or "making the leap" phenomena seems to be an important way of getting out of the metastable state of an unsatisfactory status quo. ***It's not necessarily the case that people procrastinate because their emotions aren't engaged, because clearly for #36 her emotions were engaged -- they just were in conflict.*** *She had emotional needs to get exercise, which were in conflict with her fear of riding. That is the nature of the "hump" she had to get over.* Hume and Irvine talk about this -- how reason works by playing off one emotion against another and thereby achieve better outcomes. Both #18 and #36 provide examples of this dynamic.

[05/02/07] I've been thinking about the ***different forms that procrastination can take.***

- *Fully intending to do something, and just never quite getting around to doing it (being lazy, or trapped by inertia -- the status quo is not sufficiently bad)*
- *Not being very enthusiastic about doing something inevitable, and dragging your heels hoping the problem will go away on its own (failure to articulate a vision)*
- *Hesitation, indecisiveness, and vacillation in deciding a proper course of action (failure to articulate a plan)*
- *Being bored with something, and engaging in distractions (playing games of Risk; spending lots of time on formatting) which are more interesting than the real work (failure to enact a plan)*

It is important to engage the emotions as a way of breaking out of this pattern of vacillation. Otherwise, the rational response of "Why I should do this" is counterbalanced by equally rational responses for "Why I should not do this." This is deeply connected to the utility property (clincher, perk, wash, drawback, and show-stopper) -- the need to find a strong enough motivation to ensure action of one sort or another. In rereading this memo, I'm struck by #8's comment above: "maybe it's on sale now" which echoes what Arthur and Donna told me about running a bakery: have a sale of one sort of another going on all the time. Why? It gives people that extra added incentive to act now, as opposed to any other time. ***A clincher doesn't have to provide sufficient motivation all by itself. It only has to be sufficient reason to act now, as opposed to any other time.***

See also today's entry in the Intentionality memo.

[06/26/07] After I met with Jeff Mapes today I finally managed to come up with a typology for procrastination.

- ***Denial*** is inordinate preoccupation with side-issues as a subconscious strategy for avoiding unpleasant truths. (Tolstoy's story about the soldiers) Janis and Mann 1977?
- ***Vacillation*** is an inability to achieve closure on a decision. The emotions are essential to terminating the decision process.
- ***Foot dragging*** is a strategy to delay action in the hope that the need for action will disappear on its own. Strictly speaking foot dragging is not denial, for it is a conscious strategy; nor is it vacillation, for the needed action is usually clear, if unpleasant or undesirable.

- ***True procrastination*** occurs when a commitment is made to a course of action, and that course of action is seen as the correct and necessary thing to do, but the decision maker simply never quite gets around to doing it. It remains on the to-do list for days, weeks, months, years. The decision maker is insufficiently motivated to carry out the intended course of action. What is lacking in this case is sufficient emotional reward for action or punishment for inaction.

M.55. Prompting Event

[05/08/06] This seems like an example of a "prompting event" or something that forces action (e.g., our automobile accident in 2002 that totalled our car and forced us to start taking TriMet.) Otherwise it's easy to keep procrastinating by keeping it on the 'to do' list week after week, until finally it drops off from lack of interest. This seems like it might be a particularly important factor in Flexcar adoption, where signing up for the service isn't the same thing as trying it for the first time!

[07/24/06] *It's interesting that in quote (14:88) that #10 did not procrastinate in his decision to try riding his bike to work.* "I took the emotional leap of just doing it...I just did it." The prompting event in this case may have been the regret associated with buying the pass ('perhaps it's not too late to return it?') together with the fact that he was already having to expend mental energy on learning the routines of a new job. It's interesting that he states *"I just didn't want to think about it, didn't want to deal with it in my own mind."*

See research on habit-breaking, cited in Kottonau, Burse, & Pahl-Wostl (2000). This article gives a nice review of literature touching on my topic and is well worth rereading.

[10/09/06] #14 gives an interesting discussion in (26:41) -- she had several of the prerequisites set up for a bike commuting trial: dissatisfaction with her car; limited recreational use of her bike; exposure to biking role models; prompting event. And yet...

B: Had it ever crossed your mind before then that, in addition to using your bike for recreational purposes, you might actually be able to use it for commuting?

#14: Not seriously. We have two people who are faculty in my department who ...one of them, they just recently bought a car, because his wife was saying 'We've got to buy a car.' But they only commuted by bike, everywhere. The other one has a car, but does commute in by bike. They both live closer in than I do. And so, I thought...even though they were around and doing it, *I never really seriously thought about it until I saw the 'Bike to Work for a week.'*

...she is unable to give it serious consideration because the amount of stuff she must carry. It's a "deal-breaker" which overrides her desire to explore the possibility.

M.56. Selection Process Bias

[7/12/06] I met Timo Forsberg at the Bike Summit and then again last night at the Sweet Summer Cycle event (his cell phone number is listed on the handout, 503.806.3415). However, I must disagree with the statement he makes here that the point of change is the decision you make in the morning; rather, it's the decision which unfolds more gradually during the days and weeks leading up to that first morning you decide to try riding your bike to work. *Adoption is different than selection.*

It seems curious to me, but as an outsider to the urban transit world, the conversations I've had so far with people with an urban transportation background seem to suggest a certain strange blind spot about innovation adoption (e.g., the meeting I had with Jennifer Dill, where she immediately recognized my description of selection as being their prevailing view.) There seems to be a pervasive sense of now-ness in their thinking, as suggested by the TriMet ridership survey I took earlier in the year. Perhaps

shaped by their way of thinking about transportation issues, transit agencies seem to place all of their emphasis on the selection process, and little to none on the adoption process. It is reminiscent of the divide between the behaviorists, who are interested only in the external manifestations of the psyche, and the cognitivists, who are willing to dive into the 'black box'. Transit agencies don't care what people are thinking, they care what people are doing: it's a purely prescriptive way of looking at the world, and it's bound up with the research methods they use. (This is a familiar issue from Rogers; source bias strongly influences the kinds of questions which are asked, and consequently which methods are used; over time these become the dominant methods, because they aren't trained to use anything else.)

[07/17/06] Adoption is the process of adding another option to the evoked, inert, or inept set. Selection is the process of choosing an option from one of those sets. It seems to me that this has important modeling implications.

The evoked, inert, and inept sets are properties of needs.

When a primary need is generated for which there are no evoked options, it provides the impetus for an adoption search to try and identify technology candidates. What happens when there are no inert candidates, either? Does this define a killer application -- a candidate which is the only viable solution to a primary need?

The teme is the association which is created in response to a lack of technology candidates. Temes have states and behavior, reflecting the evolution of experience toward the need-technology association. Somehow, when the teme achieves an equilibrium state with respect to a solution candidate, it triggers some sort of state change in that need. Perhaps adoption occurs when all subneeds in a need have viable evoked candidates, or else their relative priority is updated to demote them from primary needs to perks?

M.57. Sleep on it

[03/10/07] In writing up the issues list for #33 I was struck by something he said -- when describing his process for big ticket decisions he said he likes to sleep on it. What happens when we "sleep on it"? It seems like a way of dealing with conflict -- just the opposite of a "no brainer" -- something that not only requires thought, but unconscious processing of thought. Things come to us in our dreams, we turn over the day's events and get in touch with deeper parts of ourselves that are hard to access when the daytime narrative self is dominant. It's a time to adjust, to reflect on our goals, to make sure it's what we really want. It's also a way of buying time for additional information to come our way. Many times I've found that by waiting, by putting off an immediate decision, sometimes the problem will solve itself. It's both a strategy for minimizing regret and a way of structuring a dominant choice. It seems different from procrastination somehow. Sleeping on it is not an indefinite putting-off; it puts the decision off for a specific, limited period and allows a cooling off so that rash decisions are not made solely on the basis of the emotions. Sleeping on it is one technique the rational mind uses to hold the emotions in check and prevent us from simply reacting to the excitement of the moment.

M.58. Stretching and Cocooning

[02/23/07] In reviewing the issues list for #26 and #21 it occurred to me that there's another property here that I've missed up until now -- *mood*. This property gets at emotional energy, focus, openness, opportunity cost -- the *cost of cognition*. As I'm fond of saying, thinking is hard work and people will avoid it if they can. It takes energy to follow up on new opportunities, and it's evident from #26, #21, and #18 that people who are in a period of recovery from physical or emotional trauma are focused on maintaining their comfort zone. Their focus and energies were directed inward.

By contrast, several others in the study mentioned wanting to stretch or move beyond their comfort zone, specifically #10, #14, #20, #23, and #25. This was associated with a period of personal growth and renewal, of energies directed outward.

I've never seen explicit consideration of emotional mood in previous discussions of adoption, but the influence of positive and negative affect has been studied in the context of decision psychology (although not extensively.) See Isen, A.M., Positive affect and decision making, in W.M. Goldstein & R.M. Hogarth (eds.), Research on Judgment and Decision Making, Cambridge: Cambridge University Press, 1997, pp. 509-536. This may also be related to the certainty effect (Tversky and Kahneman, 1981) as well as loss aversion. See also Plous pg. 99-100 for discussion of Zelkhauser's "Russian Roulette" example, as well as Slovic, "The Perception of Risk" pg. 413-429 on the bookshelf; there are also some more Isen references in the back of the Slovic book. There also seem to be strong ties here to framing as well as self-image (e.g., reconnecting with childhood) which brings image theory into it as well.

This property seems to be about emotional mood -- but what is mood? What exactly is being conferred here? It is cognitive or affective? Certainly it seems strongly tied to the emotions and framing, and operating in the domains of gains/losses (from Prospect Theory). *Some attributes of this property (or is it a category?) include "circling your wagons", having "too many irons in the fire", having "too many balls in the air", "withdrawing from the world", "pulling in and taking care of yourself", "having a lot on your mind"; the antipode of this property includes attributes such as "moving beyond one's comfort zone", having a "stretch goal", "reaching out" or "engaging" with the world, etc.*

There are structural implications here in the size of the decision frame, and the willingness to unpack the frame. Unpacking requires emotional and mental energy; it does not come for free.

M.59. Successful advocacy and opinion leadership

[03/01/06] In a way, #3 put herself out on a limb here. She'd never actually used Flexcar herself, so by offering it as a solution to the group's problem she was putting herself at something of a social risk if things didn't work out and they were late to the work meeting -- particularly since she'd only been working for PSU for two months at that point. As it happens, things not only worked out for the best, but the positive reaction of her coworkers to the Flexcar innovation transferred to her to some extent. Somewhere in here there's a social gambit involved in offering new information about innovations, which if successful may help to improve the informant's position in the social network (i.e., this is part of how opinion leadership gets built.)

[08/08/06] #4 also puts himself in an advocate's position, but here (17:103) there's less social risk involved: he's doing it for himself. The benefit is functional rather than social.

[12/29/06] *Rosen (2000) has some interesting things to say in Chapter 11 about why people pass along word-of-mouth information. WOM is new, relevant, and exciting. Telling new information is rewarding; a feeling of importance rubs off. Having 'inside information' implies that you are well-connected (i.e., a high-status individual). WOM travels much faster when you give them a hero; people like to feel good about heroes. Humor also helps. Articulating what's so special is much of what underlies buzz (i.e., clinchers)*

M.60. Technology-centered identity

[07/05/06] I think technology can play an important role in the formation of social identities (e.g., the Open Source movement, Linux, bicycles, skateboards, etc.) but the question is: under what circumstances does this occur? How is bicycle adoption different than, say, coffee maker adoption? It can't simply be facilitating social interaction, because coffee makers (arguably) do that. No, it seems like identity construction happens when technology serves as the glue which binds together the various threads of one's life (arcs). One constructs meaning from the adoption of technology by using it as a lens

which brings into focus previously important threads or arcs, and giving them expression; the act of finding these connections is intense, pleasurable, and deeply exciting -- we feel a powerful need to tell others, to evangelize, to encourage them to form the same connections. Thus does a bicycle take on greater significance than a mere means of transportation. Walking is a means of transportation, but I haven't yet hears of a "walking summit".

[07/11/06] #5 alludes to a technology-centered identity here, which he describes as "bikes-as-a-lifestyle".

[07/26/06] I hypothesize that part of the construction of such an identity involves rite-of-passage events like the one #10 relates in (14:99) about riding in the rain. On the other hand, in a later passage #10 says that his adoption of bicycling is purely function...so perhaps rite-of-passage is necessary but not sufficient to construct a technology-centered identity? Or perhaps not even necessary...?

[07/27/06] Certainly in #4's case (17:47) there was no discernable rite of passage (unless perhaps it was riding out-of-control downhill with no brakes!) He seems to have developed an affinity for recreational bike use based on the socializing within his group of friends at Reed, and his later use of bikes for commuting seems to have been a natural extension of his earlier recreational riding.

[08/08/06] There's a nice in-vivo quote from #4 in (17:114):

> #4: Yeah, I think we definitely differentiate ourselves. We would not be cyclists that would wear [racing] jerseys [laughs] so we're in that category of not taking cycling seriously in terms of athleticism, but more of a larger...I don't know, it's more of an identity issue than it's sort of an athleticism issue. We get around biking, instead of for health, but because that's what you have to do, that's sort of the way to go.

[09/19/06] During the interview with #25, I was struck by the fact that this informant is motivated primarily by internal factors such as the challenge, getting exercise, and learning rather than external factors. He seems interested in the mechanical details of biking to a far greater degree than me -- and yet he also describes his biking experience as being primarily functional rather than identity-centered. *I see interesting analogies between functional vs. identity-centered adoption and the three dimesions of religious belief per Bateson -- intrinsic, extrinsic, and seeker. Perhaps functional and identity-centered adoption are independent dimensions rather than mutually exclusive states; but devising a test of that would be better done using survey research and factor analysis.* For the Winter Bikes case, it raises the possibility of a hypothesis: informants who rate low on an identity-centered adoption scale would be less likely to perserve all winter? But I suppose informants who were biking because of cost issues (high on the functional scale) might also be likely to continue...

[06/01/07] In looking at the experiences of some of the Winter Bikes informants (esp. #23 and #27) it is clear that biking culture (or transit-friendly culture, generally) played a role in their decision to move to Portland in the first place. This is an aspect of bicycling adoption that can't be explained solely in terms of biking infrastructure: the behavior of drivers, the atmosphere of bike-tolerance, the supportive attitudes of city government -- these all play a role in the growth of biking and indeed make it possible for the political will and funding to be found for biking infrastructure. Thus, there are complex feedback loops operating here, and the physical infrastructure is only part of the equation. One of the strengths of agent-based simulation is that it makes it possible to integrate elements from the physical and social environment in a single model. This would be a good point to stress in the paper I'm proposing for bridging the gap between traffic field research and multi-agent simulation. What cultural elements make Portland (etc.) hospitable for biking and transit, and how do these translate into increased funding and public support for alternative transportation modes? This argues for explicit consideration of personal and social psychological factors in multi-agent transportation modeling.

M.61. Technology cults

[03/02/06] Could this "microcommunity" phenomena be connected in some way to the formation of "technology cults" like TiVo or the free software movement?

Could perhaps be an indication of the quality of adoption? Perhaps this phenomena occurs when a particular pattern of needs falls into place with a satisfactory technology candidate? Could technology be acting like the "floating bit of trash" which provides the initial impetus to the formation of a microcommunity of like-minded individuals ("cult")?

[07/27/06] Certainly "chopper" bikes seem to have provided an opportunity for shared recreational outlets among #4's circle of friends at Reed (17:47)

M.62. Temors and Momors

[08/19/06] Doing a bit of reading about memetics, to see if my use of this term is way off base. Evidently, it's not -- largely because *there is no accepted definition of what a meme is.* People have spent quite a bit of time arguing about definitions, in fact (Hales and Marsden, 2002; Edmonds 2002). Wilkins (1998) traces the development of this term and points out that it's been applied to quite a number of things; it parallels 60 years of arguments about what a gene is, until DNA was mapped. There's a nice quote in Wilkins: "A theoretical term is usually generated to denote a causal nexus in the model the theory describes. On at least one recent account (Suppe 1989, van Fraassen 1980) a scientific theory is an attempt to either isolate or idealize a system -- usually a physical system -- in such a was that its dynamics can be reduced to a manageable number of variables (each of which is usually represented by a theoretical term) related by a mathematical description, so taht the model generates a restricted number of likely outcome states." That certainly tracks with what I'm trying to do here.

The whole thrust of my theory of adoption is that 'innovations' do not have ontological status, but are instead emergent, dynamic patterns of how needs are associated with technologies. That's very close to what Dawkins was talking about in The Selfish Gene -- according to Wilkins, Dawkins only mentioned memes in passing -- and entirely tracks with the idea that innovations are 'run time' structures in computer science parliance. However, I do not think it is helpful to say that innovations are memes; to do so would be to repeat the mistake of thinking of innovations, and memes, as objects rather than relations or associations between objects (here 'objects' is being used in the CS sense of the term.) Thus, there is nothing 'solid' about a meme; if you want to get at what is distinctive about an innovation, you have to look at the social or psychological forces that tend to keep it glued together. Thus, I think it is entirely appropriate to use the terms meme and teme to describe those forces which hold together (or force apart) emergent patterns of motives.

Thus, one of the problems with the term 'meme' is that it has been reified, much as 'innovation' has been. Memes, innovations, and temes are not structured objects; they are a emergent set of relationships brought about by underlying forces, and which manifest themselves only at run-time when they are instantiated. From Wilkins pg. 6: "Dawkins' original introduction of the term 'meme' in The Selfish Gene mentioned in passing statches of tunes, crazes and fads, but the paradigmatic example he gave, no doubt due to his personal experience of it, was a scientific notion passed from scientist to scientist. [...] Typically, scientific ideas are either evocative metaphors, like de Candolle's 'struggle for existence' that inspired Darwin, or more or less formal models. It is the latter that concerns us here, for when metaphors reach the end of their evocation, they must be turned into formal models anyway in order to be tested against quantifiable phenomena. A formal model like Boltzmann's thermodynamic entropy is a far cry from Heraclitus' notion of flux, and it does a great deal more conceptual work. The significance of Dawkins' example is that one can, to a relative degree of exactness, determine whether and how far a part of whole of a model has spread to another scientist or textbook, or whatever one takes to be the cultural equivalent of the

phenotype -- for reasons I hope become clear, I shall refer to this as the phemotype, and the total distribution of coadapted memetically constituted traits within a lineage the phemorph of that lineage. The neologisms are strained, barbarous and ugly, but I hope they will add some clarity to what is being discussed. In short, scientific examples can be quantified both in terms of their frequency in a lineage of scientists, and their relative rates of increase or decrease. This susceptibility to analysis is essential for modelling change in terms of natural selection and evolution in general."

Others have made this point as well. Dawkins' view of memes as replicators has been disputed by David Hull, who argued that interaction and not replication was the essence of evolution; this has been called the Hull-Dawkins Distinction. "Hull's general view of evolution is of a cycle of replicators coding for interactive traits, which through their interactive success acquire (or fail to acquire) the resources needed for further reproduction." (Wilkins 1998, pg. 7)

Wilkins seems to anticipate the point I'm making here. "The view I am advocating here is neither individualist, nor holist, but a view known as 'emergentism' (Nagel 1961): the doctrine that the properties of a collective whole arise from the relationships between the properties of the components. Simply understanding the componential properties, without understanding the connections between them does not enable us to model the higher level thing they comprise." (pg. 10)

As Wilkins defines it (pg. 13), "A meme is the least unit of sociocultural information relative to a selection process that has favorable or unfavorable selection bias that exceeds its endogenous tendency to change." The 'favorable or unfavorable' part really seems to anticipate the valence of the teme/meme association. It hasn't occured to me until reading Wilkins just now, but of course this meme/teme valence is going to inevitably lead to some kind of selection bias among networks of motives.

Wilkins mentions that one model of memes is epidemological in nature (e.g., Goodenough and Dawkins 1994; Lynch 1996; Dennett 1995: 364-368). He likens memes to a kind of "mind virus". What surprises me is that they seem to be applying the epidemiological metaphor apparently without any knowledge of the diffusion of innovations literature!

He raises the interesting point that memes, unlike biological evolution, doesn't make you more fit; they simply propagate, that's all (cf. Groupthink.)

[08/29/06] It seems to me that the central philosophical question I am addressing, the one which gets to the heart of my inquiry, is: ***How is thought organized?*** What is its logical structure? What is the nature of the connections linking one thought to another? (glue, links, chains, logic) How does thought behave, and how does this behavior give rise to organized structure?

Questions such as What is consciousness? What is the mind? What is intentionality? What is volition? How are the brain and the mind linked? etc. are related, but tangential to the question I seek to explore. Questions such as What is a meme? miss the point in some sense, I think, because they reify the emergent run-time structures of collective thought rather than seeking to understand the underlying organizing processes; or else, they attempt to impose an inappropriate genetic metaphor onto the processes of thought, rather than seeking to understand it in its own terms.

[11/25/06] From the Wikipedia entry on memes, retrieved today:

One important criticism of meme theory hinges on the following question:

"If memes are the solution, what is the problem?"

Critics in this vein point to a dearth of useful applications of meme theory in its two decades of existence. Beyond highly general explanations of highly complex phenomena (especially religion), meme theory has yet to produce, according to critics, a solid case-study of a concrete phenomenon that has gained acceptance among either scientists or social scientists. Rather, they contend, all memetic studies have done is translate conventional social thinking into "meme language" - without adding new explanatory value.

This criticism continues by asserting that no reason exists for differentiating or discerning the word "meme" from the word "idea" or from the phrase "pattern of thought".

In response to these criticisms, a memeticist might characterize the intitial question as misleading (the word "explanation" or "descriptor" might seem more apt than "solution"). The creation of the term "meme" - as opposed to "idea" or "pattern of thought" - allows for specific description and application of the meme as a phenomenon. Additionally, using a new term such as "meme" allows one to avoid semantic baggage associated with well-known terms such as "idea"; and conveys a (mistaken) connotation of novelty.

This cirticism seems to underscore the point I'm trying to make here, that *"innovation" is to "idea" what "teme" is to "meme"*. If the term "meme" is not simply to be a synonym for "idea", then there must be some way of clearly distinguishing between the two -- and to my way of thinking, "meme" should stand for the organizing process which gives rise to an idea. An idea is an emergent, run-time structure; a meme is the design-time process which gives rise to an idea (the 'glue' which holds an idea together). In this way of approaching it, innovations and ideas are conceptually analogous, and differ only in certain aspects of their underlying generating processes. *Innovations require the application of tools whereas ideas do not.* Nevertheless, innovations can have a significant ideational component (what Betz calls the ***schema*** of a technology) as well as a technology component (which Betz calls the ***morphology*** of a technology.)

The question becomes: is there really a clear distinction between and idea and an innovation? An idea is an innovation which does not require a physical technology; but what does it mean to say that an idea "requires" something? Is this simply a distinction without a difference? I'm still puzzling that one out.

[11/25/06] Here's another interesting quote that brings another part of *Hume's Treatise of Human Nature* into the fray:

...memeticists have started to see memes not as atomic but as complex interactors in an environment of other memes and physical entities, a development pre-figured perhaps in the theory of the association of ideas in the eighteenth and nineteenth centuries [citation needed]. However, such a response would require memetics to prove it had some value to add to such complexity in order to prevent it falling into the same disuse as the theory of association of ideas.

[...from the entry on association of ideas:]

The theory of the association of ideas is the name of a theory first propounded by Aristotle (De mem. et rem., 2), where he identified three contexts in which ideas might be associated.

The three contexts are:

- Similarity
- Contrast
- Contiguity in time or space

Perhaps its most influential classical development was by David Hume in his A Treatise of Human Nature Part I section IV, and later in An Enquiry Concerning Human Understanding III:19. His three contexts are:

- Contiguity in space or time
- Resemblance
- Cause and Effect

Hume's theory of causation suggests that the third type might collapse into the first, in that one of his criteria for causal relationships is "constant conjunction" (see e.g. A Treatise of Human Nature Part III section XIV-XV).

[11/25/06] The Wikipedia entry goes on to list some **important criticisms of memetics**:

- *Lack of philosophical appeal.* Reducing "memes" into their underlying constituents will invariably mean the loss of important properties and

richness of context. Another criticism is that memetics seems to reintroduce or reinforce Cartesian dualism (in this case, gene/meme as an analogy to body/mind.) My response to this point is covered in the discussion between the structured and anarchic perspectives, which I see as essentially the same argument (see today's entry in the "Design-time vs. run-time and the structured vs. anarchic perspectives".)

- *Explaning, or renaming?* Memetics has yet to make any useful predictions or lead to any useful applications. As yet there seem to be no reason for distinguishing the term "meme" from the word "idea" or the phrase "pattern of thought". I have covered this point above: by defining a "meme" more narrowly as an interaction rather than an object of some sort, a meme (design-time structure) can be clearly distinguished from an idea (run-time structure).
- *Lack of rigor.* Memetics does not adequately distinguish between genotypes and phenotypes. This point is covered above: clearly distinguishing between design-time and run-time structures helps establish a clear conceptual difference. Phenotypes are analogous to run-time structures (emergent structures); genotypes are analogous to design-time structures (generating processes.)
- *Analogy with viruses.* Some critics have argued that memetics intermittently applies an analogy with viruses. I think this point can be addressed by noting the similarity of epidemiology and the diffusion of innovations, as well as the distinction between a teme and a meme.
- *Accusations of pseudo-science.* There exists no imaginable event which memetics cannot explain; therefore memetics is a tautology. To address this it is important to establish the boundaries of the theory -- when it applies, and when it does not. "According to some critics, memetics has joined extraterrestrial, exo or xenobiology as a science devoted to a subject matter whose very existence remains in dispute!" (Blute 2005)

[03/09/07] To avoid unnecessary confusion and controversy, I think it's probably better to propose a name other than "meme" to denote the relationship between two needs. In keeping with my nomenclature I've decided to call it a *"mome" (for MO-Motive rElation)* while *"teme" continues to stand for TEchnology-Motive rElation*). I can then use meme to refer exclusively to the emergent structure, analogous to an innovation. *A mome is to a meme what an teme is to an innovation*, or a genotype is to a phenotype (although I'm not quite sure if the last analogy holds; I don't know enough about phenotypes and genotypes to be sure.)

The distinction between design-time and run-time structures reminds me a bit of Plato. A design-time structure is an archetype; it is akin to one of Plato's ideal forms. A run-time structure has been instantiated.

[04/15/07] I've decided to throw in the towel on "meme". It's just too loaded down with baggage. I think one major problem here is that memes have inappropriately combined two different levels of analysis: interaction and replication. I'm interested applying the interactive aspects of the meme construct without getting dragged into the controversies about its replicative aspects, which I do not asubscribe to.

I also noticed today that the Journal of Memetics ceased publication in 2005 due to lack of quality submissions. Edmonds (2005) writes an obituary for the concept. In certain respects I'd say good riddance -- I think memetics has become too idealogical and associated with the agenda of fundamentalist atheists like Dawkins and Blackmore. The meme concept is just too tainted by its origins in evolutionary biology and its ongoing war with organized religion. Interestingly, *Gatherer (2005) argues that reapproaching memetics from the standpoint of object-oriented analysis could help to rescue memetics from its 'malaise'.*

That's not to say that the meme idea didn't have certain virtues -- it joins catastrophe theory and other failed systems concepts in that respect. It may return someday in a new guise.

So anyway, to eliminate any suggestion of a tie to memetics, I've decided to rename temes to temors (TEchnology-MOtive Relation) and momes to momors (MOtive-MOtive Relation).

M.63. The 'Ah-ha!' Experience

[7/7/06] Over and over again I find myself returning to the theme of gestalt psychology and sudden flashes of insight; sudden and unexpected connections; solutions that occur to you in a flash; events, discontinuous change, punctuated equilibrium, etc.

[7/10/06] The "ah-ha!" phenomenon could be a sign that there is a change in a metastable state, settling into a new "ground level".

[07/31/06] See Benson (1999, pg. 98) for a tie to insight learning theory (Kohler) and gestalt psychology.

[08/01/06] #4 lends some interesting insight on this phenomena in quote (17:84). It seems like these insights aren't quite so sudden as they first appear -- preceding the sudden realization is a slow period of gaining experience with the technology (thereby mitigating the potential for unknown risks and dread risks), observing role models, becoming discontent with one or more aspects of the current option. *The insight only comes once the state of the system is primed and ready for it* (cf. Schein's conditions for change, and Goldspink's discussion of the sensitivity of a system to external shocks; see also self-organized criticality and catastrophe theory). See the memo entitled "From the inert set to the selection set".

[10/13/06] *It appears that emotions are necessary to the 'ah ha' insight.* Support for this idea comes from Damasio's work with hyperrational patients (cited in Irvine, pg. 113-115) who seem unable to terminate the analysis process for even simple decisions like scheduling the next doctor's appointment. It makes sense, really, because *the sentiment of "just do it!" is inherently nonrational.* It also reminds me of Penrose's argument in The Emperor's New Mind that cognition is inherently noncomputational: computers lack the capacity to step outside of an argument and recognize when it's unsolvable (the halting problem.) *This seems like a very important fact worth restating: the famous "halting problem" in computer science occurs because computers lack emotions, which are essential to terminate the analytical component of decision making. Pure computational analysis cannot terminate.* The halting problem of computer science is familiar to us by another name: "analysis paralysis."

M.64. The framing, adoption, and selection processes

[03/02/06] I think technology use may be understood in terms of three distinct, but interrelated processes.

Framing refers to the process of identifying which needs are relevant to achieving some intention, goal, or mission. (The actual formation of intention is way beyond the scope of this theory.) It is not assumed that this process is rational or planned; rather, it is assumed that framing is principally an associative activity, based on the history of past decision outcomes. (See Antonie Jetter's presentation on fuzzy cognitive mapping -- lots of potential for modeling the framing process here.) In the decision psychology literature no one has yet proposed a comprehensive theory of framing (c.f., Beach and Lipshitz 1996.) I believe the reason for this is that framing is an inherently run-time phenomena which is steeped in history (c.f., Heidegger's 1949 Letter critique of Sartre, discussed in Introducing Existentialism pg. 110 ff.) In discussing the design-time structural and behavioral aspects of the framing process, one must be careful not to assume that the whole process has been described. It is history-dependent; the run-time aspects are crucial. (Thus, it cannot be fully described *even in principle*, but it can be simulated.)

The needs which are identified by the framing process constitute the ***framing set***. To avoid having to consider needs individually -- a cognitively expensive task -- the

framing set can be collapsed or ***reframed*** into a single need which is composed of many subordinate needs. "I need to go grocery shopping" entails a whole constellation of subordinate needs, some of which have prior solutions, which are **assumed** in order to avoid the cognitive cost associated with having to redecide them every time (**learning**). It is possible to **unpack** a need into its constituent subordinate needs, but this process requires deliberate thought as framing is a largely unconscious process.

Adoption refers to the process of forming associations between needs and technologies which relate to those needs. There are three potential outcomes: a technology can be **evoked** (brought to mind through positive memories) on the basis of the needs in the framing set; it can be **inept** (brought to mind through negative memories) and hense avoided in this situation; or it can lie **inert** -- judged potentially useful on the basis of older memories, but not a frequent choice and hense not as easily recalled during the act of technology selection. Adoption is the process of forming evoked (useful), inert (potentially useful), and inept (contraindicated) associations between needs and technologies.

Selection is the process of choosing a technology to solve a need presently at hand on the basis of prior associations.

[11/20/06] See today's "norm theory and framing" memo for an interesting insight on the framing process.

M.65. The incommensurability of regret

[07/25/06] There seems to be a certain incommensurability to regret. Regret is a feeling of conflict over the outcome of a decision, but that conflict stems from factors which are particular to the decision; thus, it is difficult to compare regret in one situation to regret in another, since the underlying factors are often different.

As #10 says here (14:93) 'I just missed the bus' triggers feelings of social guilt due to being late to work. Not so purchasing the annual pass; in that case, the regret seems to stem more from squandering money unnecessarily. Thus, the underlying causes of the regret are different. So regret is useful mainly as a way of generalizing feelings of internal conflict over the outcome of a decision, but it is important to unpack that regret before it can shed light on just why the regret is occurring.

[02/23/07] Maybe regret is incommersurable because it's a general process rather than an "object" to be reified. Maybe regret occurs as we shift from the domain of gains into the domain of losses? (See Prospect Theory)

M.66. The Morning Debate

[05/17/07] At IAMOT 2007. During the composite sequence analysis for Winter Bikes I keep coming across examples of 'the daily debate' -- informants who (due to circumstances or personal decision making style) elected to make transit mode decisions on a day-by-day basis, vs. those who preferred to surrender to habit (collapsing the decision).

There's a nice in vivo quote from #33: "I'm a different person before I've had my morning coffee and make decisions on a different basis." See *Isen (1997) affect and decision making* (PSY 510 notes).

Habitual: #20, 21, 26, 27, 36

Daily debate: #22, 23, 25, 31 (see F13:15), 33, 41

Regardless of whether they were able to collapse the decision into a habit or not, the continuance/discontinuance rate doesn't seem to be significantly different between the two groups. A bigger sample would be needed.

M.67. "This idea has changed my life"

[03/20/06] A bit of hyperbole, perhaps, but there's a lot of stuff lurking in this quote. I wish I knew what the person quoted in this article meant by lawyers not wanting to visit clients in a car like this (presumably a violation of the image that successful people drive big, expensive cars) as well as what she meant by "this idea has changed my life."

[07/10/06] Alternatively, perhaps *a life-changing experience results when adoption of a technology triggers the collapse of self-image problems occuring in another, unrelated part of one's life*. The technology then becomes the key which unlocks the door to other ways of constructing meaning from the world. *I would not expect this phenomena to happen in all cases of adoption -- only those situations where the state of the cognitive system is in a "high-cost" mode, i.e., the individual is expending a lot of mental cycles dealing with stress, anxiety, uncertainty, etc. and finding the technology (or other key idea) triggers a collapse in these other problems so that a solution manifests itself, thus relieving the individual from the burden of having to continue to expend mental resources on these personal problems.* This need not be a complete collapse; but it should be enough to result in a significant savings in cognition. *Thus, there would be a difference between "value-centered" adoption and "identity-constructing" adoption.*

[07/24/06] In (14:87) *#10 also discusses a period of change in his life (starting a new job) and that this served as a catalyst for taking the leap and biking to work.* This ties in with Lewin's unfreezing and attitudes of psychological openness to new possibilities, but this type of change seems different and contrasts to "this idea has changed my life" as cited above. In that article the informant is reflecting back over all the changes that the technology has brought about; it's retrospective as opposed to the immersive kind of change that #10 discusses; #10 was *in* the moment, not reflecting on a moment that had passed.

[10/09/06] In (26:27) #14 contextualizes her decision to begin riding MAX and using Flexcar as part of a broader theme of using less consumable resources like gas, and simplifying her life. This was triggered by a move from a larger house to a condo and the subsequent downsizing of her possessions. She did not say what prompted the move -- and I didn't ask her -- but one guess would be that after 29 years working at PSU (see 26:18) *#14 is planning for her retirement, and this life-change has prompted her to reevaluate priorities* she had previously accepted without a lot of critical reflection. She mentioned exercising more, and buying a bicycle which she is using for recreational purposes. *This parallels what I recently heard in the first round of Winter Bikes informants (esp. #20 and #23) who became empty-nesters and entered a period of reevalation of who they are now, and got back in touch with bicycles as a way of reconnecting with something that had been important to them at an earlier stage of their lives.*

[10/13/06] See the 9/21/06 entry in the "bike culture vs. mass transit (non)culture" memo.

[11/07/06] In coding the issues list for #10 I am struck by this quote in (14:87): (edited for clarity)

> #10: *In the back of my mind it was like 'You could bike that. You can definitely bike that.' But I had this emotional... like, you know... I just didn't want to think about it, didn't want to deal with it in my own mind. There's the whole, 'Is it going to be safe? It's going to be cold, it's going to be wet. Is your bike good enough? You're going to get hit by a car.' And then, just like the second day I worked here, I was in this moment of change in my life, I was starting a new job. And I just put on my bike clothes, and I biked to work. I just did it.*

This ***"experimental moment"*** strikes me as one of the salient features of the personal dimension on adoption, at least as far as bikes are concerned. Rationally there are all kinds of arguments that can be made against biking, especially all-weather biking. But he set aside those concerns, and in no small measure because an experimental moment was taking place in his life; it is a moment when habits are interrupted. As JMS says in The Deconstruction of Falling Stars, "Salah -- pause and consider." (I'm not sure how the Hebrew word is spelled.) This "emotional leap" seems to set the personal dimension on adoption apart from the social or functional dimensions.

M.68. Timeouts vs. Counts

[5/19/06] Timeouts seem more potent than counts, and I am finding more examples of timeouts in my interviews. Perhaps that is because timeouts tend to be 'hard' and associated with absolute dates ("Sale ends Friday!") whereas counts tend to be more relative, at least when they're self-imposed. For example, I may begin shopping for a car by deciding that I want to look at at least three models, but once I'm in the showroom it's easy to lose this resolve (why three? It's entirely arbitrary.) Of course, there are also examples of externally-imposed counts that are absolute ("Limit one per customer!") but somehow I'm having trouble visualizing examples of how a count would influence the decision making process in the same way as a timeout.

Unless a count influences the transition path sequence (e.g., count < 1, count = 1, count > 1 forcing three different paths) whereas a timeout tends to influence the occurence of triggering events ("Sale ends Friday! Act now!")

An interrupt can serve as a limit, too. "I've been meaning to do something about that, and this event just reminded me that I need to fish or cut bait."

This reminds me of something Donna said about running a bakery: always have something on sale. This gives people a reason to come in, as opposed to procrastinating by continually thinking about coming in but never actually bothering to do it. A sale is a reason to come in today, and not to wait for something better to come along. It's about playing on one's fears of loss or regret!

[08/17/06] See today's entry in the procrastination memo for some important thoughts about timeouts and counts.

[08/24/06] In (23:68) #8 discusses setting various arbitrary timeouts as a strategy for overcoming procrastination (Feb., then May, then Aug) -- and blows right through them. The problem is that if the intellect sets these deadlines arbitrarily, then it can violate them just as arbitrarily. This is predicted by Irvine's theory of motivation. *"My intellect will have a hard time justifying the terminal desires it forms... my intellect will be unable to come up with anything more profound... than a feeble, 'I just wanted to.' Indeed, my intellect could just as easily have formed the opposite desire... and it knows it. For this reason, nonhedonic terminal desires tend to be pale, insubstantial things."* (Irvine, 2006, pg. 71)

[08/28/06] Another interesting exchange with #8 here in (23:73):

B: ...what's the difference - what in your mind was different - that said 'Okay, now is the time to do it'?

#8: I'd say two things. The cost of...two cost issues, sort of. The gas price is going up, and learning that Flexcar, maybe it's worth the (when I thought it was) $25. But that's not...when gas is $1.50, or $1.40, it's not that big a deal. When it's $3.09, it's kind of a different deal. The $25, then...it pays for itself quite quickly. And then, the other thing is the convenience. I mean, we don't have to do this anymore, then we don't have to worry about...if [my husband] has something going on that day, he won't have to worry about this. I will go do it, I will take care of it. So it's taking on the responsibility.

And yet, based on her e-mail of Aug. 24, #8 has not yet taken action to sign up for a service which is essentially free. Perhaps in part this is because there are no hard, externally-imposed deadlines; neither the gradually rising gas prices (a count) nor her self-deadline of August to sign up for the service (a timeout) proved to be sufficient. Just as her intellect self-imposed a limit, it could just as easily rationalize its way out of cancelling it if the emotional commitment wasn't there -- thus counts and timeouts are only as powerful as the underlying emotional motivation. *This suggests that there may be a cancellation mechanism which operates if the timer expires without finding a killer application. Procrastination is not a state so much as a recurrent pattern of timer/count expirations and reschedulings:* ***procrastination is a guard condition.***

M.69. TTM: The Hummer and the Bicycle

[08/17/06] Last night I went ahead and computed the TTM scores for the Passport Plus informants. I had hypothesized that, if I sampled across the full range of CBAM scores, then I could expect to see a similarly uniform distribution of TTM scores. That was not the case. There was a "central tendency" (in a loose sense, since the TTM produces ordinal data) toward the contemplation and action stages. No informants were found in the precontemplation or maintenance stages, suggesting that something else is going on here. The CBAM appears to be tapping something different than the TTM, lending support for the notion that adoption and rejection are not flip sides of the same coin.

My best guess at this point would be that the TTM is tapping an axis of sentiment about car culture, from precontemplation at one extreme (exemplified by Hummers, 'conservation is a private virtue', 'global warming is a hoax', 'we're not running out of oil') to maintenance at the other (exemplified by bikes for commuting, Car Busters magazine, Peak Oil). If this were true, then administering the TTM questionnaire to a group of Hummer owners and attendees at a Peak Oil potluck would tend to produce opposite classifications. I might expect the informants in my bike cohort (at least the ones who no longer own cars) to score high on the maintenance scale.

It's tempting to use the Hummer and the Bicycle as symbols of these opposite extremes, but the bike in particular is an imperfect symbol. Commuter biking might be a good symbol of environmentalism, but recreational biking is not; one might well imagine a 4WD Hummer toting a mountain bike on the back bumper. In fact #4 alludes to this contradiction in (17:133). Certainly many people who consider themselves part of a larger 'bicycle community' have environmentalist sentiments and may tend to view the bicycle as a symbolic identity of sorts -- but that picture is complicated by the knowledge that there are many types of cyclists. These indicate many cultural fault lines operating within the 'bike' subcommunity a la Abbott's The Chaos of Disciplines.

But the Passport Plus informants fell in between these opposite extremes -- all of them within the contemplation category ('Cars are a problem for the environment, and I'm probably contributing to it, but what can you do?') or the action category ('It's not a perfect solution, but at least I'm trying.') In retrospect this makes sense. Many of these informants own cars, and in any case buses and Flexcars are gasoline powered vehicles themselves. Mass transit allows its adherents to plausibly maintain that they have reduced their carbon emissions, but obviously they have not eliminated them entirely.

And yet, this dimension seems different from a technology cult somehow. It seems to pertain more to the self-image arc which precedes adoption, and thus applies more to a functional aspect. Or maybe what I'm seeing is that Passport Plus just lends itself more to functional adoption (and hense does not lend itself to the formation of affinity groups and subcultures) whereas Bicycles lend themselves more to affinity adoption and subcultures? If that's the case I would expect to see informants in the Winter Bikes case scoring more in the action and maintenance categories than the PP+ informants.

M.70. Using behavioral traps to overcome procrastination

[07/24/06] On reading this passage from #10,

> "The idea is that it motivates me to get on my bike, and it *definitely* motivates me not to drive my car." (14:76)

...I was struck by something I had also read from #5's interview:

> "And I thought, 'If I have that, that will encourage me not to want to drive.'" (11:85)

There's an aspect in which deliberately burning one's bridges can act as a motivator to stick with something. This is a deliberate strategy to use the irreversability of the decision and regret as a positive motivating force to overcome discounting and ensure continued application of will. This is saying something very important about needs, how the perception of needs is plastic and changes with time. Long-term needs that

require the application of willpower, like exercising for health, tend to get overwhelmed by short-term desires which promise immediate gratification, like being lazy, sitting around watching TV, and eating ice cream. Commiting to an irreversable course of action can be a positive boon because it harnesses regret to keep up the motivation. The influence on decision making is through the framing process in some way.

[07/26/06] This is echoed in #10's decision to return the PP+ pass (14:102) because not having the pass meant that in good weather "there's no excuse not to bike." Presumably if he had the pass he'd be feeling like he's wasting money on it if he doesn't use it, therefore it becomes an excuse to avoid biking (and thus the unpleasant prospect of exercising.)

[07/27/06] #4 gets at this too, in (17:42): "I feel like if I have the Passport it will be easier for me to roll out of bed and go 'Ah, I'll just get on the bus today.' This is something to followup on with the bike cohort: do they have a TriMet pass? And what impact does that have on their resolution to keep riding their bikes?

[08/01/06] See also the discussion of behavioral traps in Plous (1993).

[08/11/06] Irvine (2006) discusses this issue on pg. 75ff. "...although the intellect cannot command the emotions to commit to one of its projects, it might be able to trick them into committing." *Perhaps as a way of getting past procrastination?*

[10/13/06] See #18's comment in (32:37):

> #18: And I pay $5 a day! I don't have a parking pass. I've been paying $5 a day since October. I don't do it every day, sometimes I take the bus. But *I keep paying $5 a day because I don't want to get a parking pass, because I'm working towards going on the bus every day.*

She bought the transit pass to serve as a behavioral trap which would encourage her to ride the bus every day, but it didn't provide sufficient motivation for her to overcome her aversion to the bus (plus the fact that she's not a very organized person -- one might fairly conclude that her 'disorganization' is really a subconscious effort to sabotage her own efforts to ride the bus.) She's been caught in a behavioral trap of her own devising.

M.71. Value-centered adoption

[03/28/06] #3 took the job based in part on her ability to utilize the technology -- thus the desire to adopt the technology constitutes an important force in her life.

[05/25/06] This seems to have been a factor for at least a couple of other informants (#10).

[07/10/06] ...and #5 as well, with his decision to purchase a house based in part on the commute.

[07/12/06] This is not the same thing as construction of a technology-centered identity. Here her technology adoption is value-centered; a technology is chosen which comports with her self-image and values. By contrast, a technology-centered identity actually seems to have the power to reshape the values themselves. "I wanted to be able to use mass transit, so I chose the PSU job" is somehow different from "I see myself as part of the bicycling movement." But how? Perhaps in value-centered adoption, the self-image comes first, leading the individual to adopt the technology; whereas in construction of a technology-centered social identity, the adoption of the technology comes first, followed by positive changes in the individual's social structure (networks) triggering changes in self-image and personal values?

M.72. Wilsonville: Forced Rejection

[2/28/06] #3 wanted to make greater use of the technology (public transportation, Passport) but not always able to use it herself -- particularly when she was working in Wilsonville. She was thwarted by availability issues. She was forced to reject public transportation, despite having a favorable attitude and wanting to adopt. Instead, she had to rely on driving her car.

APPENDIX N. NETWORK DIAGRAMS

In Atlas-ti network diagrams are the principal vehicle for axial coding, each category having its own diagram. These diagrams are used to establish linkages among the properties and dimensions of each category.

N.1. Developing an Interest

This category pertains to the development of initial interest. Commuter biking and recreational biking are often described as different worlds: "a threshold you break". Why is this? How are bicycles seen as solutions to such disjoint sets of needs? This category seems to be saying something fundamental about the nature of innovation: Why do certain types of innovation regularly originate with people on society's margins?

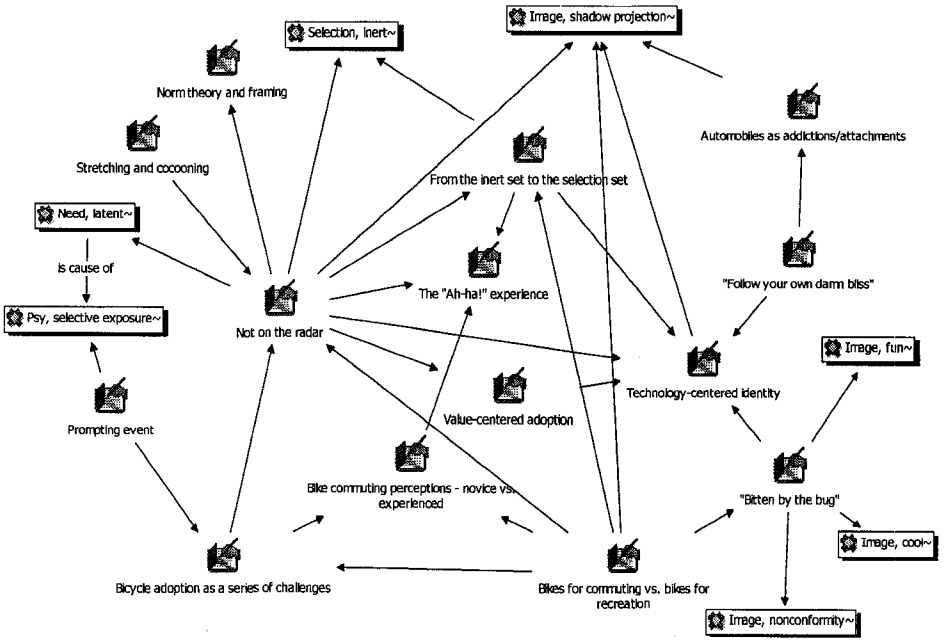


Figure 100. Network Diagram for "Developing an Interest"

N.2. Exploring the Possibilities

This category is about exploring the need for an innovation: discovering whether it would be something really useful (a clincher), or just nice to have (a perk).

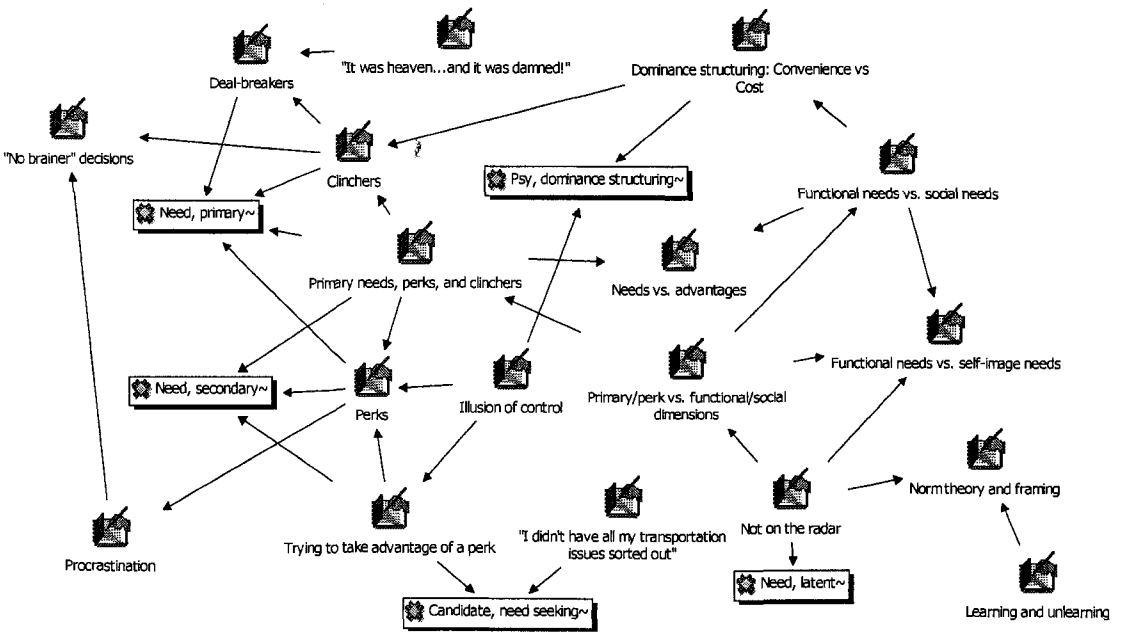


Figure 101. Network Diagram for "Exploring the Possibilities"

N.3. Getting Over the Procrastination Hump

This category is about balancing the value of adoption against the time and effort required to make a decision. This process manifests itself through status quo bias, social loafing, reticence to act, and similar psychological mechanisms. Why do something rather than nothing? Is there an easier way?

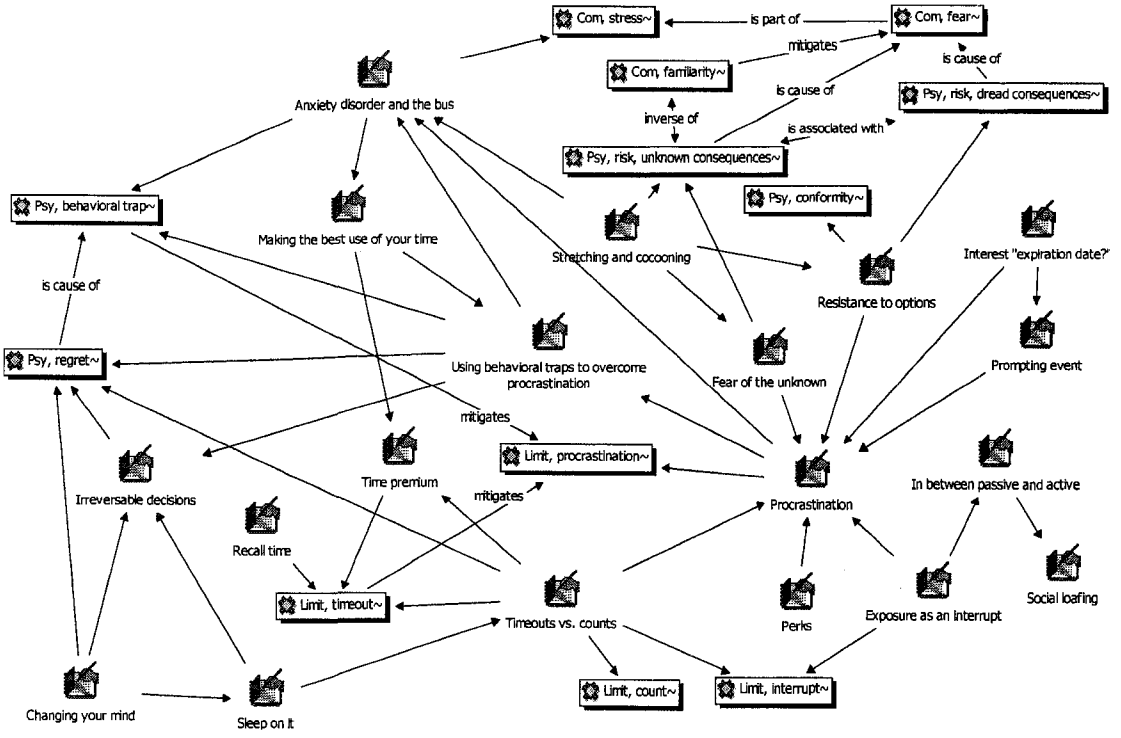


Figure 102. Network Diagram for "Getting Over the Procrastination Hump"

N.4. Thwarted Intentions

This category is about what happens when needs are thwarted: involuntary use, blocked use, involuntary discontinuance, and blocked discontinuance.

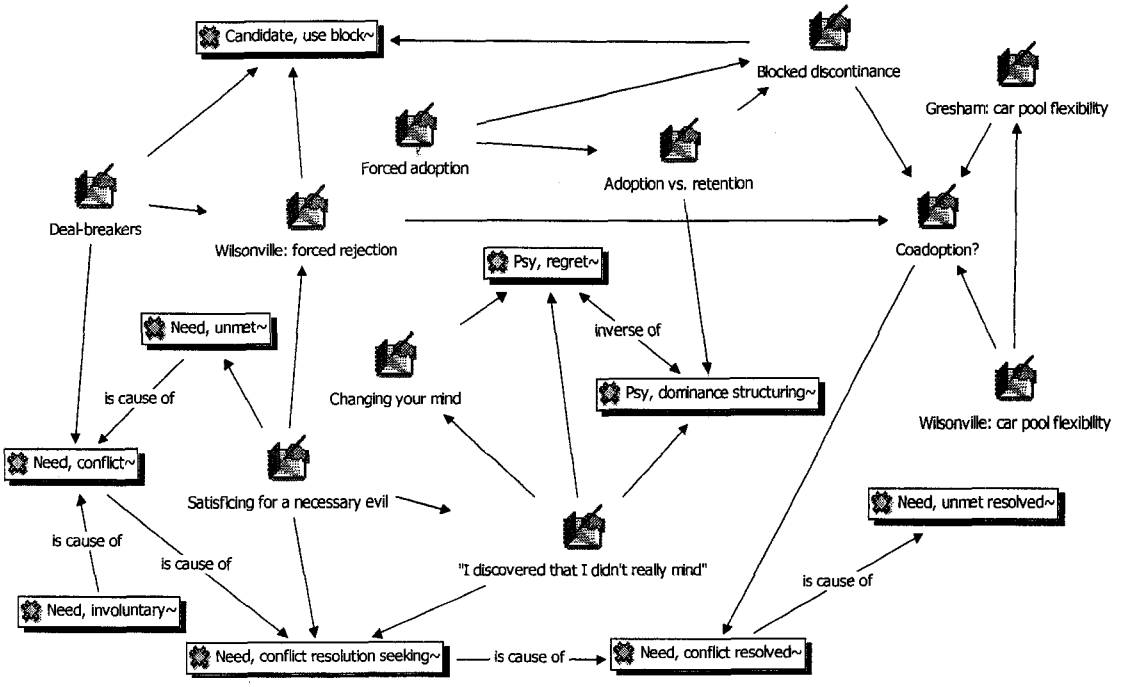


Figure 103. Network Diagram for "Thwarted Intentions"

N.5. Collapsing the Decision

This category is about balancing the pros and cons of a set of options to arrive at a final, summary judgement (collapsing).

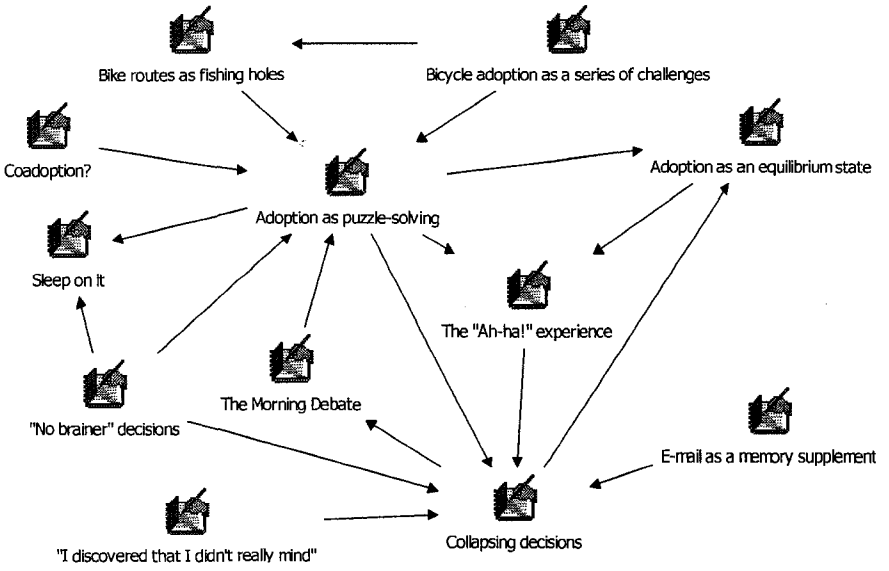


Figure 104. Network Diagram for "Collapsing the Decision"

N.6. Becoming a Habit

This category is about gaining experience, obtaining mastery, and becoming comfortable with use of an innovation – in other words, the process of habit formation.

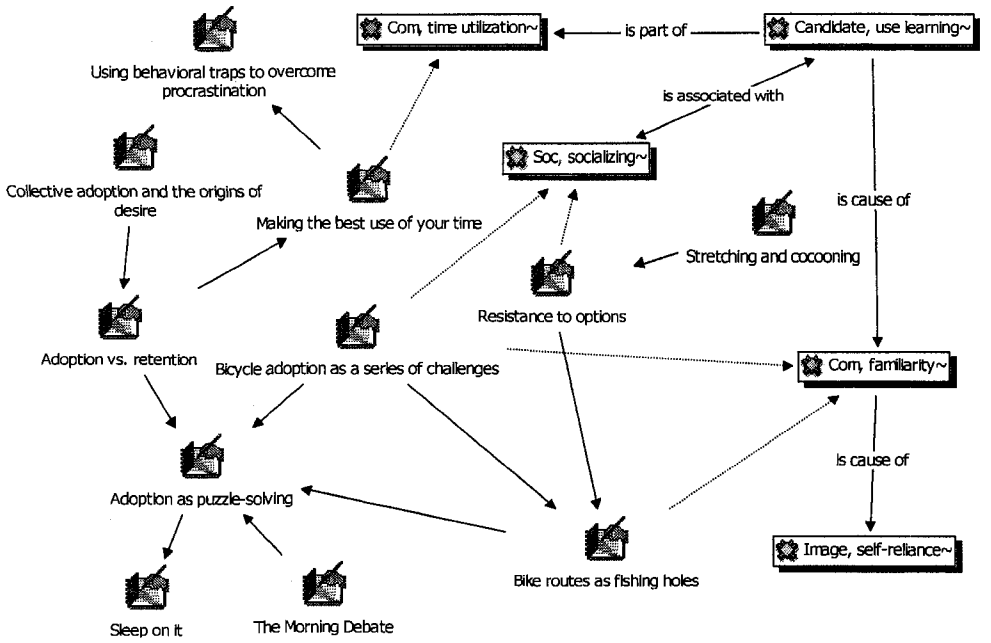


Figure 105. Network Diagram for "Becoming a Habit"

N.7. Constructing a Narrative

This category is about the process of constructing stories of 'why' our decisions unfold as they do.

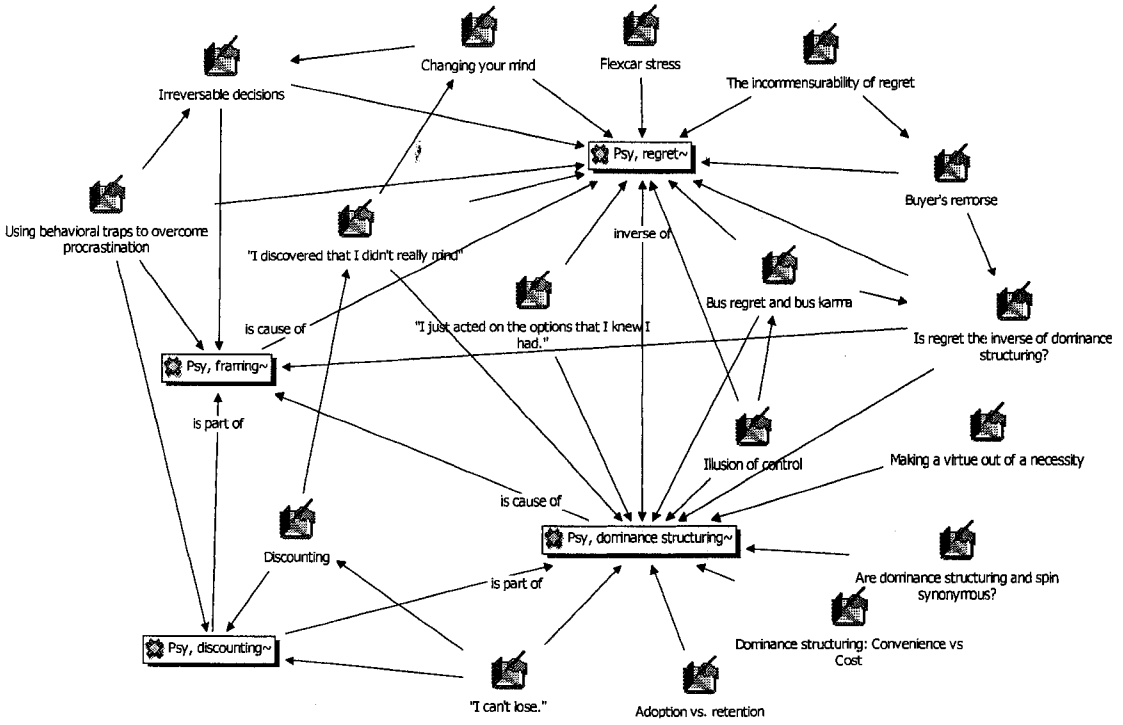


Figure 106. Network Diagram for "Constructing a Narrative"

N.8. Adoption as Means

This category relates to the functional dimension of technology adoption.

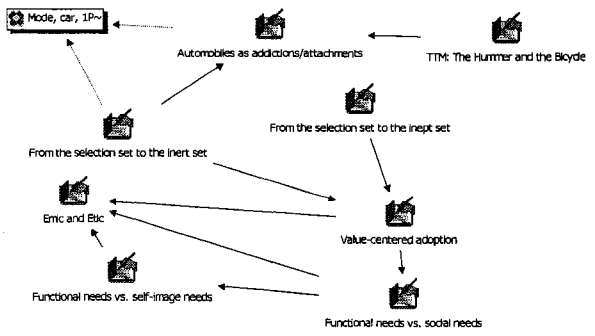


Figure 107. Network Diagram for "Adoption as Means"

N.9. Adoption as End

This category relates to the social dimension of technology adoption.

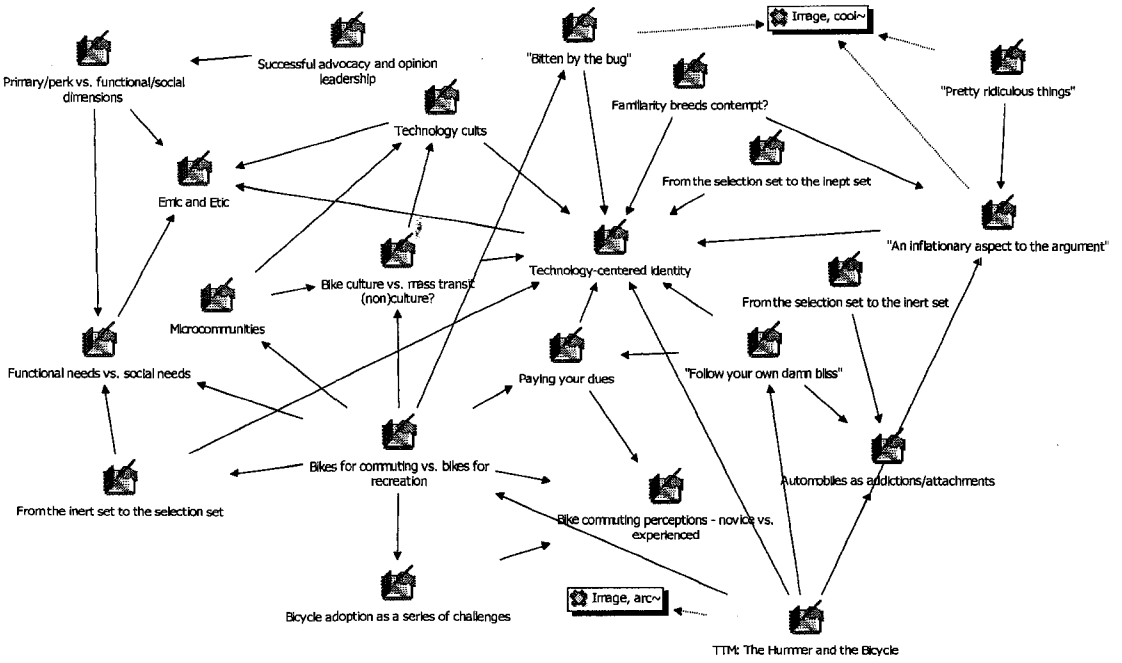


Figure 108. Network Diagram for "Adoption as End"

N.10. Adoption as Quest

This category relates to the personal dimension of technology adoption.

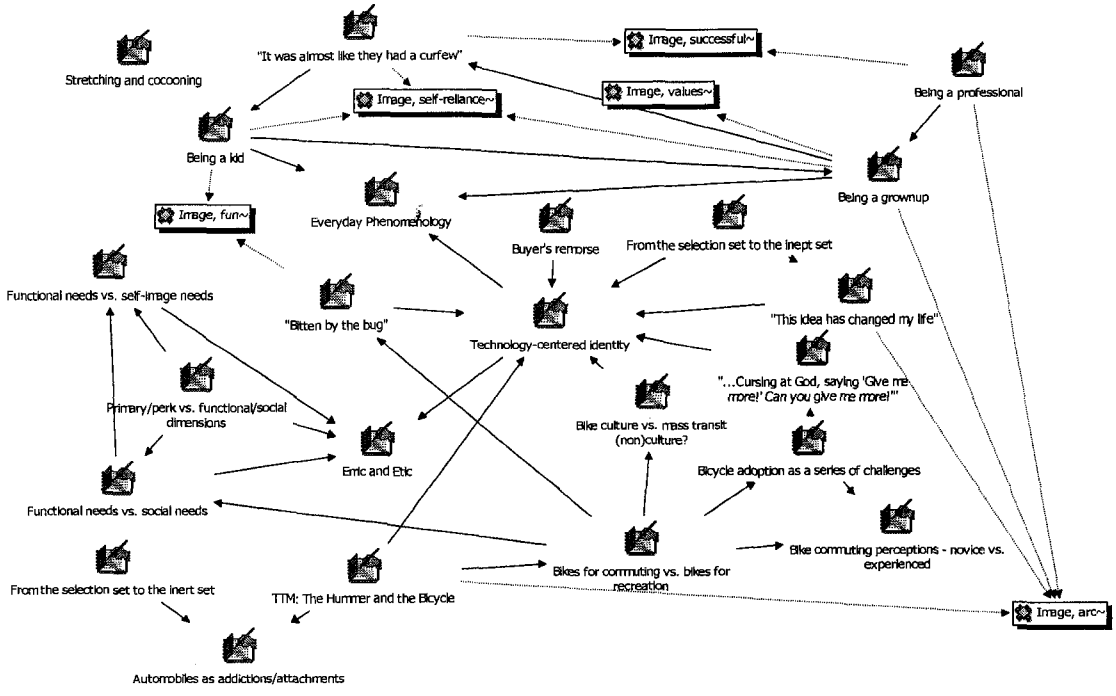


Figure 109. Network Diagram for "Adoption as Quest"

N.11. The Structural Model

This diagram links memos pertaining to the structural aspects of the GAM.

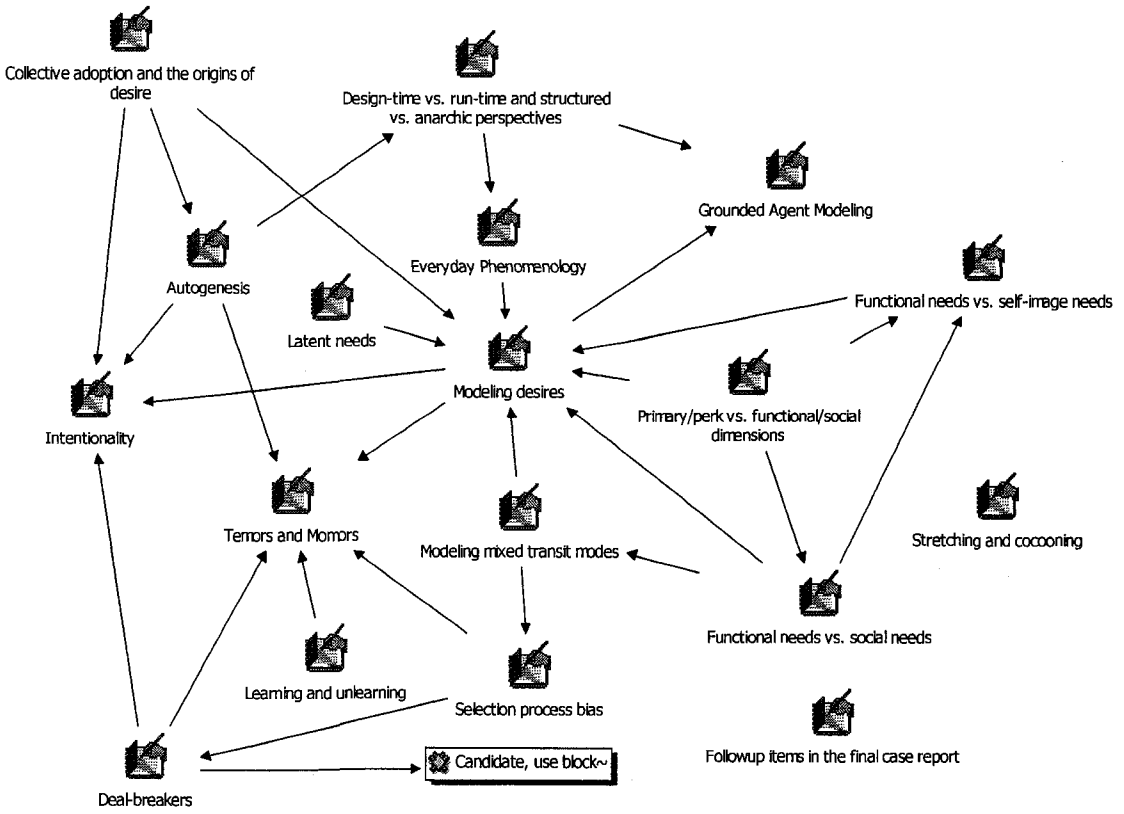


Figure 110. Network Diagram for "The Structural Model"

N.12. The Behavioral Model

This diagram links memos pertaining to the behavioral aspects of the GAM.

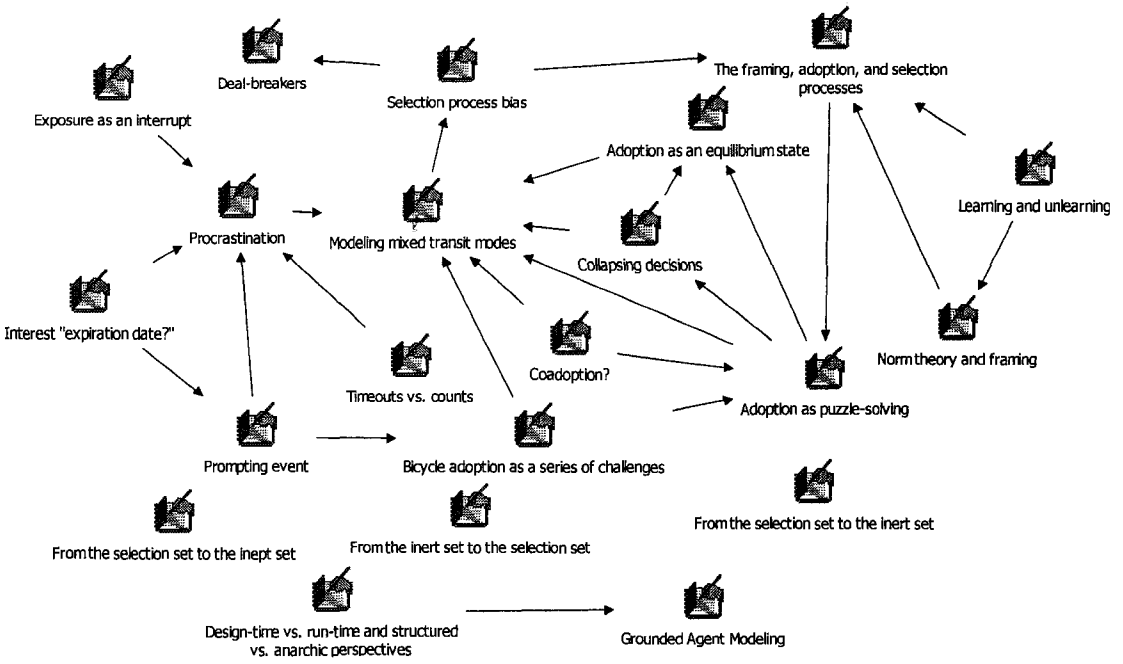


Figure 111. Network Diagram for "The Behavioral Model"

APPENDIX O. SEQUENCE DATA

TABLE 21. EVALUATION PROCESS CODES

Tag	Code	Description
1ST	First application	First use of an option to address a situational need (note: not necessarily the first use of the option.)
ATT	Attribute event cause	Judging the cause of an event within the present situational context
CON	Consolidation	Removing a contingency between a need and an option (i.e., its suitability no longer depends on another motive.)
CXT	Evaluate event context	Determining the needs of the present situational context.
DIF	Differentiation	A nuanced association between a need and an option (i.e., its suitability now depends on another motive.)
DOM	Dominance structuring	Judging a technology option to be a good solution to a situational need.
EVTE	Evaluation event	Evaluating a situational need and/or a technology option on the basis of new information.
IGN	Ignore option	Ignoring the event which prompted the evaluation.
INT	Interest	Expressing interest in a potential solution to a situational need.
NEV	Negative evangelism	Discouraging others from using an option.
NOP	No operation	Discard the token without taking action (internal code).
PEV	Positive evangelism	Encouraging others to use an option.
TRY	Trial use	A technology option is judged sufficiently promising that its use is warranted, given the right circumstances.
UON	Update optional need	A change has occurred among the needs which must be satisfied for an option to be viable.
USN	Update situational needs	A change has occurred among the situational needs.
VAL	Access event valence	Assessing the value of an event to the current situation.
VIO	Violation	A technology option is judged to be a mismatch to a situational need.

TABLE 22. MAINTENANCE PROCESS CODES

Tag	Code	Description
BLK	Use block	An external block is thwarting further action.
BLKR	Use block removed	Removal of the external block which was thwarting action.
BUY	Purchase equipment	An equipment purchase is required to use the technology.
JUNK	Dispose	Dispose of a technology (junk it.)
EVTM	Maintenance event	Action is required over and above what is normally involved in evaluating or using the technology.
EXP	Expiration	Subscription expires.
FIX	Repair	Equipment repair is required to use the technology.
SELL	Sell	Sale of equipment required to use the technology.
SUB	Subscribe	A subscription (or renewal) is required to use the technology.
UNS	Unsubscribe	Unsubscription is required to discontinue using the technology.

TABLE 23. SELECTION PROCESS CODES

Tag	Code	Description
ACT	Action initiated	Actually carrying out the selected course of action.
AON	Assess optional need	Determining additional needs which must be satisfied for the option to be considered as a viable solution.
AR	Action required	A prompting motive is judged in immediate need of action.
CLO	Closure timeout exceeded	Sufficient time and effort have been expended on this topic, and it is time for a decision.
CMT	Commit to option	An intention is formed to use a technology option.
EVTS	Selection event	A motive prompts the need for technology use.
FSN	Frame situational needs	Determining which needs are relevant to the present situation.
MO	Multiple options	More than one option may be used to satisfy the needs of the situation.
MT	Make tradeoff	Trading off needs when no single option presents a dominant advantage in the situation.
NO	No options	No options were found which will satisfy the situational needs.
OO	One option	Exactly one solution option was found which satisfied the needs of the situation.
PRO	Procrastination	Consciously or unconsciously delaying implementation of a decision.
QUIT	Abandon motive	A prompting motive is judged in immediate need of action but there is a lack of options. The prompting motive is abandoned.
QUITX	Can't abandon motive	A prompting motive is judged in immediate need of action but there is a lack of options. The prompting motive cannot be abandoned.
QUO	Status quo	A prompting motive is judged not in immediate need of action.
RCL	Recall option	Mental recall of an option which may be useful in the current situation.
RSN	Reframe situational needs	Reframing the current situation in such a way as to simplify the decision task.
SCO	Screen option	An option is evaluated to determine whether it satisfied the needs of the present situation.
SEN	Sensitive motive	A prompting motive exists for which there are no good solutions.

TABLE 24. INTERRUPT GROUP CODES

Tag	Code	Description
SH	Seek help	Seeking personal assistance (as opposed to information) from an experienced party.
SI	Seek information	Seeking information other than personal assistance from one or more sources.

TABLE 25. EVALUATION PROCESS SEQUENCES

ID	Case	DD	Evaluation Episode	Evaluation Sequence
1	PP+	1/3	Interested in Flexcar	EVTE CXT VAL ATT UON INT SI TRY
3	PP+	3/2	Interested in Flexcar	EVTE CXT VAL ATT UON INT TRY
6	PP+	3/2	Evaluating first Flexcar use	EVTE CXT VAL ATT UON 1ST DOM
7	PP+	3/2	Regular Flexcar use	EVTE CXT VAL ATT UON DIF
9	PP+	4/2	Regular Flexcar use	EVTE CXT VAL ATT UON DIF
10	PP+	5/1	Interested in Flexcar	EVTE CXT VAL ATT UON INT TRY
13	PP+	6/3	Flirts with Flexcar	EVTE CXT VAL ATT UON INT
14	PP+	6/3	The moment passes	EVTE CXT VAL ATT USN (coping in an emergency)
15	PP+	8/2	Friend signs up for Flexcar	EVTE CXT VAL ATT UON IGN
16	PP+	8/2	Flexcar promo	EVTE CXT VAL ATT UON IGN
17	PP+	8/4	Vacillates about Flexcar	EVTE CXT VAL ATT UON INT TRY
18	PP+	8/5	New Flexcar information	EVTE CXT VAL ATT UON TRY SI
21	PP+	8/5	Evaluating first Flexcar use	EVTE CXT VAL ATT UON 1ST DOM PEV
22	PP+	14/2	Interested in Flexcar	EVTE CXT VAL ATT UON INT SI TRY
25	PP+	14/2	Evaluating first Flexcar use	EVTE CXT VAL ATT UON 1ST DOM
27	PP+	14/3	Evangelizes about Flexcar	EVTE CXT VAL ATT UON PEV
28	PP+	17/3	Initial Flexcar evaluation	EVTE CXT VAL ATT UON IGN
29	PP+	17/3	New Flexcar information	EVTE CXT VAL ATT UON INT
31	PP+	18/2	Disenchanted with Flexcar	EVTE CXT VAL ATT UON USN (getting a new apartment)
34	WB	23/4	Flirts with Flexcar	EVTE CXT VAL ATT UON INT IGN
35	PP+	4/1	Biking at Reed	EVTE CXT VAL ATT UON INT TRY 1ST DOM
36	PP+	4/2	First "fixie" ride	EVTE CXT VAL ATT UON 1ST DIF
39	PP+	4/3	Evaluating first trip to campus	EVTE CXT VAL ATT UON INT TRY 1ST DOM
40	PP+	4/3	Evaluating summer biking	EVTE CXT VAL ATT UON PEV
41	PP+	5/1	Early commuter biking history	EVTE CXT VAL ATT UON INT TRY 1ST DOM PEV
42	PP+	5/1	Considers biking to PSU	EVTE CXT VAL ATT UON INT TRY
44	PP+	5/2	Fall - evaluating bike commuting	EVTE CXT VAL ATT UON 1ST DOM PEV
45	PP+	10/1	Memphis: hit by car	EVTE CXT VAL ATT USN ("it's just Memphis")
48	PP+	10/1	Eugene: evaluating bike commuting	EVTE CXT VAL ATT UON INT TRY 1ST DOM
49	PP+	10/1	Eugene: hit by car	EVTE CXT VAL ATT UON DIF
50	PP+	10/1	Eugene: stops biking	EVTE CXT VAL ATT USN (breaks ankle)
51	PP+	10/2	Forest Park: too dangerous to bike	EVTE CXT VAL ATT UON VIO
53	PP+	10/3	PSU: the rainstorm	EVTE CXT VAL ATT UON DOM
55	PP+	14/2	Recreational biking with friends	EVTE CXT VAL ATT UON INT TRY 1ST DOM
59	PP+	17/2	Evaluates biking to park-and-ride	EVTE CXT VAL ATT UON INT TRY 1ST VIO
60	PP+	18/4	Bike evaluation	EVTE CXT VAL ATT USN ("I don't think bikes should be on the road.")
64	WB	20/2	Missouri: child born	EVTE CXT VAL ATT USN (child born)
65	WB	20/3	Empty nest	EVTE CXT VAL ATT USN (taking stock of life)
66	WB	20/3	Flirts with bike commuting	EVTE CXT VAL ATT UON INT TRY
70	WB	20/4	Evaluating summer biking	EVTE CXT VAL ATT UON 1ST DOM
71	WB	20/4	Decides to try winter biking	EVTE CXT VAL ATT UON DIF
73	WB	20/4	Evaluating winter bike commuting	EVTE CXT VAL ATT UON CON VIO
75	WB	21/1	PDX: evaluating bike commuting	EVTE CXT VAL ATT UON DIF CON VIO
76	WB	21/2	Diagnosis and recovery	EVTE CXT VAL ATT USN (life-threatening illness)
77	WB	21/3	Mom's 3-speed to the rescue	EVTE CXT VAL ATT UON INT TRY

ID	Case	DD	Evaluation Episode	Evaluation Sequence
80	WB	21/4	Evaluating summer bike commuting	EVTE CXT VAL ATT UON SH 1ST DOM
81	WB	21/4	Decides to try winter biking	EVTE CXT VAL ATT UON DIF
85	WB	21/5	Evaluating winter bike commuting	EVTE CXT VAL ATT UON CON DOM
87	WB	22/2	Recreational biking	EVTE CXT VAL ATT UON VIO
89	WB	22/3	Ride to Work week	EVTE CXT VAL ATT UON INT TRY SH 1ST DOM
91	WB	22/4	Summer biking evaluation	EVTE CXT VAL ATT UON DOM
93	WB	22/5	Fall biking evaluation	EVTE CXT VAL ATT UON DIF
94	WB	22/6	New job	EVTE CXT VAL ATT USN (changes jobs)
96	WB	22/6	Winter bike evaluation	EVTE CXT VAL ATT UON CON VIO
98	WB	23/2	Biking in West Virginia	EVTE CXT VAL ATT UON VIO
99	WB	23/2	Empty nest	EVTE CXT VAL ATT USN (taking stock of life)
102	WB	23/3	PDX: Summer biking evaluation	EVTE CXT VAL ATT UON INT TRY 1ST DIF CON DOM
105	WB	23/3	Winter biking evaluation	EVTE CXT VAL ATT UON DIF
109	WB	25/2	PDX: Evaluates bike commuting	EVTE CXT VAL ATT UON INT TRY 1ST VIO
110	WB	25/3	Wife graduates	EVTE CXT VAL ATT USN (longstanding financial problems ease)
111	WB	25/3	PDX: Second try, bike commuting	EVTE CXT VAL ATT UON DIF CON DOM
112	WB	25/3	PDX: Commits to winter biking	EVTE CXT VAL ATT UON DIF
115	WB	25/4	Winter bike evaluation	EVTE CXT VAL ATT UON DIF
116	WB	26/2	Coworker diagnosed	EVTE CXT VAL ATT USN (midlife crisis - health)
117	WB	26/2	Recreational biking with friend	EVTE CXT VAL ATT UON INT TRY 1ST DOM PEV
118	WB	26/3	Sees 'An Inconvenient Truth'	EVTE CXT VAL ATT USN (environmental epiphany)
120	WB	26/3	Summer biking evaluation	EVTE CXT VAL ATT UON PEV
122	WB	26/4	Winter biking evaluation	EVTE CXT VAL ATT UON PEV
123	WB	26/4	Hit by car	EVTE CXT VAL ATT USN ("I became a statistic")
125	WB	27/2	Decides to try bike commuting	EVTE CXT VAL ATT UON INT TRY
127	WB	27/3	Summer biking evaluation	EVTE CXT VAL ATT UON SI 1ST DOM PEV
128	WB	27/4	Commits to winter bike commuting	EVTE CXT VAL ATT UON DIF
130	WB	27/5	Hit by car	EVTE CXT VAL ATT UON DIF
132	WB	27/5	Fall bike evaluation	EVTE CXT VAL ATT UON CON VIO
136	WB	31/4	Summer bike evaluation	EVTE CXT VAL ATT UON INT TRY 1ST DOM
137	WB	31/4	Decides to bike through winter	EVTE CXT VAL ATT UON DIF
138	WB	31/5	Winter biking evaluation	EVTE CXT VAL ATT UON CON DOM
139	WB	33/1	Experiments with bike commuting	EVTE CXT VAL ATT UON INT TRY
141	WB	33/1	Gives up on bike commuting	EVTE CXT VAL ATT USN ("it's just this particular bike")
142	WB	33/3	Second try on bike commuting	EVTE CXT VAL ATT UON INT TRY
145	WB	33/4	Fall biking evaluation	EVTE CXT VAL ATT USN (unprepared for winter commute)
149	WB	33/6	Summer biking evaluation	EVTE CXT VAL ATT UON DOM
150	WB	33/7	Decides to bike through winter	EVTE CXT VAL ATT UON DIF
154	WB	33/8	Fall biking evaluation	EVTE CXT VAL ATT UON CON VIO
155	WB	36/2	Thinks about biking to work	EVTE CXT VAL ATT UON INT SI TRY
157	WB	36/2	Bumpy start	EVTE CXT VAL ATT UON 1ST DIF
159	WB	36/3	Summer bike commuting	EVTE CXT VAL ATT UON DIF
160	WB	36/3	Uncertain about continuing	EVTE CXT VAL ATT UON DIF
161	WB	36/4	Fall bike commuting	EVTE CXT VAL ATT UON CON VIO
163	WB	41/3	Experiments with bike commuting	EVTE CXT VAL ATT UON INT TRY 1ST DOM

ID	Case	DD	Evaluation Episode	Evaluation Sequence
164	WB	41/3	Job ends	EVTE CXT VAL ATT USN (job ends)
165	WB	41/4	Decides to try winter biking	EVTE CXT VAL ATT UON SI DIF
166	WB	41/4	Job changes	EVTE CXT VAL ATT USN (gets job in Milwaukee)
168	WB	41/5	Occasional biking to work	EVTE CXT VAL ATT UON DIF
170	PP+	1/2	Evaluates PP+	EVTE CXT VAL ATT UON INT TRY 1ST DIF
172	PP+	3/2	Evaluates PP+	EVTE CXT VAL ATT UON INT TRY 1ST DOM
174	PP+	4/2	Evaluates PP+	EVTE CXT VAL ATT UON INT TRY 1ST DOM
175	PP+	4/3	Decreasing PP+ use	EVTE CXT VAL ATT UON VIO
178	PP+	5/1	Evaluates PP+	EVTE CXT VAL ATT UON INT TRY 1ST VIO
184	PP+	8/2	Evaluates PP+	EVTE CXT VAL ATT UON INT TRY 1ST DOM
186	PP+	10/3	Evaluates PP+	EVTE CXT VAL ATT UON INT TRY 1ST VIO
189	PP+	14/1	Evaluates PP+	EVTE CXT VAL ATT UON INT TRY 1ST DOM
191	PP+	17/2	Evaluates PP+	EVTE CXT VAL ATT UON INT TRY 1ST DIF
193	PP+	18/3	Evaluates PP+	EVTE CXT VAL ATT UON INT TRY 1ST DIF
195	PP+	1/1	Car hassles	EVTE CXT VAL ATT UON DIF
196	PP+	1/1	Bus evaluation	EVTE CXT VAL ATT UON DIF
199	PP+	3/1	Gresham: car pool	EVTE CXT VAL ATT UON INT TRY 1ST VIO DIF
201	PP+	3/1	Wilsonville: car dissatisfaction	EVTE CXT VAL ATT UON VIO
203	PP+	3/2	MAX evaluation	EVTE CXT VAL ATT UON DOM
205	PP+	4/2	Car evaluation	EVTE CXT VAL ATT UON VIO
206	PP+	4/2	Bus evaluation	EVTE CXT VAL ATT UON DOM
207	PP+	4/3	Decreasing bus use	EVTE CXT VAL ATT UON DIF
208	PP+	5/1	Car evaluation	EVTE CXT VAL ATT UON DIF
209	PP+	5/2	MAX evaluation	EVTE CXT VAL ATT UON INT TRY 1ST DIF CON VIO
210	PP+	6/1	Car evaluation	EVTE CXT VAL ATT UON DIF
211	PP+	6/2	MAX evaluation	EVTE CXT VAL ATT UON DOM
212	PP+	6/2	Bus evaluation	EVTE CXT VAL ATT UON DIF
214	PP+	6/3	Family emergency	EVTE CXT VAL ATT USN (family emergency)
218	PP+	8/2	Bus evaluation	EVTE CXT VAL ATT UON DOM
219	PP+	8/3	Unresolved transit conflict	EVTE CXT VAL ATT USN (stress on Dad)
220	PP+	8/4	Cold night with the kids	EVTE CXT VAL ATT USN (stress on kids)
221	PP+	10/1	Experiments with bus commuting	EVTE CXT VAL ATT UON INT TRY 1ST DOM
224	PP+	10/2	Car evaluation	EVTE CXT VAL ATT UON DIF
225	PP+	10/2	Stranded in Forest Park	EVTE CXT VAL ATT USN ("it was heaven...and it was hell!")
228	PP+	14/1	Tired of driving	EVTE CXT VAL ATT UON DIF CON VIO
229	PP+	14/1	Experiments with MAX	EVTE CXT VAL ATT UON INT TRY 1ST DOM
232	PP+	17/1	Car evaluation	EVTE CXT VAL ATT UON DIF
233	PP+	17/1	MAX evaluation	EVTE CXT VAL ATT UON DIF
234	PP+	17/2	Job transfer	EVTE CXT VAL ATT USN (job transfers downtown)
236	PP+	18/1	The joys of bus #154	EVTE CXT VAL ATT USN (hates the #154)
239	PP+	18/2	Car evaluation	EVTE CXT VAL ATT USN ("crappy car")
241	PP+	18/3	Bus evaluation	EVTE CXT VAL ATT UON DIF CON VIO
243	PP+	18/4	Car evaluation	EVTE CXT VAL ATT UON DIF
245	WB	20/5	Car evaluation	EVTE CXT VAL ATT UON INT TRY 1ST VIO
249	WB	21/2	Diagnosed with tumor	EVTE CXT VAL ATT USN (dizzy spells)
252	WB	22/3	Bus evaluation	EVTE CXT VAL ATT UON DIF CON VIO
256	WB	23/3	Bus evaluation	EVTE CXT VAL ATT UON DIF
258	WB	25/1	Bus evaluation	EVTE CXT VAL ATT UON DIF
260	WB	26/1	Car evaluation	EVTE CXT VAL ATT UON DIF CON VIO
261	WB	27/1	Michigan: 'loser cruiser'	EVTE CXT VAL ATT UON VIO

ID	Case	DD	Evaluation Episode	Evaluation Sequence
262	WB	27/6	Car pools with brother	EVTE CXT VAL ATT UON INT TRY 1ST DIF
263	WB	27/6	Schedule change	EVTE CXT VAL ATT USN (brother's schedule changes)
264	WB	27/6	Stops car pooling	EVTE CXT VAL ATT UON CON VIO
268	WB	31/3	MAX evaluation	EVTE CXT VAL ATT UON INT TRY 1ST DOM DIF
269	WB	31/5	Car evaluation	EVTE CXT VAL ATT UON DIF CON VIO
272	WB	33/2	Shuttle bus evaluation	EVTE CXT VAL ATT UON INT TRY 1ST VIO
275	WB	33/2	Motorcycle evaluation	EVTE CXT VAL ATT UON INT TRY 1ST DIF
277	WB	33/3	Car evaluation	EVTE CXT VAL ATT USN (lemon car)
279	WB	33/5	Evaluates MAX+shuttle	EVTE CXT VAL ATT UON INT TRY 1ST VIO
282	WB	41/1	Evaluates bus	EVTE CXT VAL ATT UON INT TRY 1ST VIO NEV
283	WB	41/5	Car evaluation	EVTE CXT VAL ATT UON DIF

TABLE 26. SELECTION PROCESS SEQUENCES

ID	Case	DD	Selection Episode	Selection Sequence
5	PP+	3/2	First Flexcar use	EVTS FSN AR RCL (Friend's car) AON SCO RCL (Walk) AON SCO RCL (Flexcar) AON SCO CLO MO MT CMT ACT (Flexcar)
20	PP+	8/5	First Flexcar use	EVTS FSN AR RCL (Dad's taxi) AON SCO RCL (Flexcar) AON SCO CLO MO MT CMT ACT (Flexcar)
24	PP+	14/2	First Flexcar use	EVTS FSN AR RCL (Flexcar) AON SCO CLO OO CMT ACT (Flexcar)
26	PP+	14/3	Searching for additional Flexcar applications	EVTS FSN AR RCL (Flexcar) AON SI SCO CLO NO SEN QUIT
38	PP+	4/3	First bike commute to campus	EVTS FSN AR RCL (bus) AON SCO RCL (bike) AON SCO CLO MO MT CMT ACT (bike)
43	PP+	5/1	Fall - commuting to PSU campus	EVTS FSN AR RCL (bike) AON SCO RCL (MAX) AON SCO RCL (bus) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (bike)
47	PP+	10/1	Eugene: bike commuting	EVTS FSN AR RCL (bike) AON SCO CLO OO CMT ACT (bike)
52	PP+	10/3	PSU: tries bike commuting	EVTS FSN AR RCL (MAX) AON SCO RCL (bike) AON SCO CLO MO MT CMT ACT (bike)
56	PP+	14/3	Flirts with bike commuting	EVTS FSN AR RCL (car) AON SCO RCL (bike) AON SCO CLO MO MT CMT ACT (car)
58	PP+	17/2	Tries biking to park-and-ride	EVTS FSN AR RCL (car) AON SCO RCL (bike) AON SCO CLO MO MT CMT ACT (bike)
61	WB	20/1	Commuting to OHSU	EVTS FSN AR RCL (bike) AON SCO CLO OO CMT ACT (bike)
62	WB	20/2	Missouri: bike commuting	EVTS FSN AR RCL (bike) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (bike)
63	WB	20/2	Missouri: schedule changes	EVTS FSN AR RCL (bike) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (car)
67	WB	20/3	Procrastinates about bike commuting	EVTS FSN AR RCL (car) AON SCO RCL (bike) AON SCO CLO MO MT CMT PRO QUO
69	WB	20/3	Begins bike commuting	EVTS FSN AR RCL (car) AON SCO RCL (bike) AON SCO RCL (MAX) AON SCO CLO MO MT CMT ACT (bike+MAX)
72	WB	20/4	Winter bike commuting	EVTS FSN AR RCL (bike) AON SCO RCL (MAX) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (bike+MAX)
74	WB	21/1	PDX: early bike commuting	EVTS FSN AR RCL (car) AON SCO RCL (bike) AON SCO CLO MO MT CMT ACT (bike)
79	WB	21/3	Tries bike commuting	EVTS FSN AR RCL (bike) AON SCO CLO OO CMT ACT (bike)
83	WB	21/4	Habitual bike use	EVTS FSN AR RCL (bike) AON SCO CLO OO CMT ACT (bike)

ID	Case	DD	Selection Episode	Selection Sequence
84	WB	21/4	Winter bike commuting	EVTS FSN AR RCL (bike) AON SCO RCL (MAX) AON SCO CLO OO CMT ACT (bike + MAX)
90	WB	22/4	Habitual bike use	EVTS FSN AR RCL (bike) AON SCO CLO OO CMT ACT (bike)
95	WB	22/6	Free parking	EVTS FSN AR RCL (bike) AON SCO RCL (car pool) AON SCO CLO MO MT CMT ACT (car pool)
97	WB	23/2	Commuting in West Virginia	EVTS FSN AR RCL (car) AON SCO RCL (walk) AON SCO CLO OO CMT ACT (car)
101	WB	23/3	PDX: Summer biking	EVTS FSN AR RCL (bike) AON SCO RCL (bus) AON SCO CLO MO MT CMT ACT (bike)
104	WB	23/3	The morning debate	EVTS FSN AR RCL (bike) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (bike)
106	WB	23/3	Daughter begins school	EVTS FSN AR RCL (bike) AON SCO RCL (car pool) AON SCO CLO MO MT CMT ACT (car pool)
108	WB	25/2	PDX: Experiments with bike commuting	EVTS FSN AR RCL (bus) AON SCO RCL (bike) AON SCO CLO OO CMT ACT (bike+bus)
113	WB	25/4	The morning debate	EVTS FSN AR RCL (bike) AON SCO RCL (bus) AON SCO CLO MO MT CMT ACT (bike)
119	WB	26/3	Summer bike commuting	EVTS FSN AR RCL (bike) AON SCO RCL (car) AON SCO CLO OO CMT ACT (bike)
124	WB	26/4	Recovering from accident	EVTS FSN AR RCL (car) AON SCO CLO NO SEN QUITX RSN CLO OO CMT ACT (car)
129	WB	27/5	Fall bike commuting	EVTS FSN AR RCL (bike) AON SCO CLO OO CMT ACT (bike)
133	WB	31/1	Commuting in Seattle	EVTS FSN AR RCL (bus) AON SCO RCL (walk) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (bus)
134	WB	31/2	Commuting in NYC	EVTS FSN AR RCL (bike) AON SCO RCL (transit) AON SCO CLO MO MT CMT ACT (bike)
135	WB	31/4	The morning debate	EVTS FSN AR RCL (bike) AON SCO RCL (MAX) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (bike)
144	WB	33/4	Fall bike commuting	EVTS FSN AR RCL (bike) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (car)
148	WB	33/6	Summer bike commuting	EVTS FSN AR RCL (bike) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (bike)
152	WB	33/7	The morning debate	EVTS FSN AR RCL (bike) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (bike)
156	WB	36/2	Experiments with bike commuting	EVTS FSN AR RCL (bike) AON SCO RCL (bus) AON SCO CLO MO MT CMT SH ACT (bike)
158	WB	36/3	Procrastinates about bike commuting	EVTS FSN AR RCL (bike) AON SCO RCL (bus) AON SCO CLO MO MT CMT PRO QUO
162	WB	41/2	Commuting to Vancouver	EVTS FSN AR RCL (bike) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (car)
167	WB	41/5	The morning debate	EVTS FSN AR RCL (car) AON SCO RCL (bike) AON SCO CLO OO CMT ACT (car)
180	PP+	5/2	Tries to find PP+ applications	EVTS FSN QUO
194	PP+	1/1	Adjunct at PSU and PCC	EVTS FSN AR RCL (bus) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (bus)
197	PP+	1/1	Consulting in downtown PDX	EVTS FSN AR RCL (bus) AON SCO RCL (car) AON SCO CLO OO CMT ACT (car)
198	PP+	3/1	Commuting to Gresham	EVTS FSN AR RCL (car) AON SCO RCL (MAX) AON SCO RCL (car pool) AON SCO CLO MO MT CMT ACT (equal split)
200	PP+	3/1	Commuting to Wilsonville	EVTS FSN AR RCL (bus) AON SCO RCL (car) AON SCO RCL (car pool) SON SCO CLO NO SEN QUITX RSN CLO OO CMT ACT (car)

ID	Case	DD	Selection Episode	Selection Sequence
202	PP+	3/2	Commuting to campus	EVTS FSN AR RCL (MAX) AON SCO RCL (bus) AON SCO CLO OO CMT ACT (MAX+bus)
204	PP+	4/2	Commuting to campus	EVTS FSN AR RCL (bus) AON SCO RCL (car) AON SCO CLO OO CMT ACT (bus)
213	PP+	6/2	Commuting to campus	EVTS FSN AR RCL (MAX) AON SCO RCL (bus) AON SCO CLO OO CMT ACT (MAX)
215	PP+	6/3	Emergency trip	EVTS FSN AR RCL (MAX) AON SCO CLO NO SEN QUITX RSN CLO OO CMT ACT (MAX)
216	PP+	8/1	Living in Sylvan	EVTS FSN AR RCL (bus) AON SCO RCL (Dad's taxi) AON SCO CLO OO CMT ACT (Dad's taxi)
217	PP+	8/2	Living in Tigard	EVTS FSN AR RCL (bus) AON SCO RCL (Dad's taxi) AON SCO CLO MO MT CMT ACT (split)
222	PP+	10/2	Living in Forest Park	EVTS FSN AR RCL (bike) AON SCO RCL (bus) AON SCO RCL (car) AON SCO CLO NO SEN QUITX RSN CLO OO CMT ACT (car)
226	PP+	10/2	Living in North Portland	EVTS FSN AR RCL (MAX) AON SCO RCL (car) AON SCO RCL (bike) AON SCO CLO MO MT CMT ACT (MAX)
227	PP+	14/1	Driving to campus	EVTS FSN AR RCL (car) AON SCO CLO OO CMT ACT (car)
230	PP+	14/1	Commuting to campus	EVTS FSN AR RCL (MAX) AON SCO RCL (car) AON SCO CLO OO CMT ACT (MAX)
231	PP+	17/1	Commuting Beaverton to PDX	EVTS FSN AR RCL (car) AON SCO RCL (MAX) AON SCO CLO MO MT CMT ACT (split)
235	PP+	18/1	Living in West Linn	EVTS FSN AR RCL (bus) AON SCO RCL (walk) AON SCO RCL (car) AON SCO CLO NO SEN QUITX RSN AR RCL (taxi) AON SCO RCL (friend's car) AON SCO CLO OO CMT ACT (taxi)
240	PP+	18/3	Living in Sellwood	EVTS FSN AR RCL (bus) AON SCO CLO OO CMT ACT (bus)
242	PP+	18/4	Commuting to campus	EVTS FSN AR RCL (car) AON SCO RCL (bus) AON SCO RCL (taxi) AON SCO CLO MO MT CMT ACT (car)
244	WB	20/5	Snow day	EVTS FSN AR RCL (car) AON SCO CLO NO SEN QUITX RSN AR RCL (bus) AON SCO CLO OO CMT ACT (bus)
246	WB	21/1	Commuting SE PDX	EVTS FSN AR RCL (car) AON SCO RCL (bus) AON SCO CLO OO CMT ACT (car)
247	WB	21/2	Commuting SE-downtown PDX	EVTS FSN AR RCL (bus) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (bus)
250	WB	21/2	You can't get there from here	EVTS FSN AR RCL (bus) AON SCO RCL (walk) AON SCO CLO NO SEN QUITX RSN CLO OO CMT ACT (bus+walk)
251	WB	22/2	Commuting downtown PDX	EVTS FSN AR RCL (bus) AON SCO RCL (walk) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (split)
253	WB	23/1	Living in Virginia	EVTS FSN AR RCL (car) AON SCO CLO OO CMT ACT (car)
257	WB	25/1	Commuting Sellwood to downtown	EVTS FSN AR RCL (bus) AON SCO RCL (car) AON SCO CLO OO CMT ACT (bus)
259	WB	26/1	Commuting Forest Grove	EVTS FSN AR RCL (car) AON SCO RCL (bus) AON SCO RCL (bike) AON SCO CLO MO MT CMT ACT (bus)
266	WB	27/7	Commuting Beaverton to PDX	EVTS FSN AR RCL (car) AON SCO CLO OO CMT ACT (car)
267	WB	31/3	Living in PDX	EVTS FSN AR RCL (car) AON SCO RCL (bus) AON SCO RCL (MAX) AON SCO CLO MO MT CMT ACT (MAX)
271	WB	33/2	Experiments with shuttle bus	EVTS FSN AR RCL (bus) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (bus)
273	WB	33/2	Experiments with motorcycle	EVTS FSN AR RCL (motorcycle) AON SCO CLO OO CMT ACT (motorcycle)
278	WB	33/5	Experiments with MAX	EVTS FSN AR RCL (MAX) AON SCO RCL (shuttle) AON SCO RCL (car) AON SCO CLO MO MT CMT ACT (MAX+shuttle)

ID	Case	DD	Selection Episode	Selection Sequence
280	WB	36/1	Commutes SE to downtown	EVTS FSN AR RCL (car) AON SCO RCL (bus) AON SCO CLO MO MT CMT ACT (car+bus)
281	WB	41/1	Experiments with bus	EVTS FSN AR RCL (car) AON SCO RCL (bus) AON SCO CLO MO MT CMT ACT (bus)

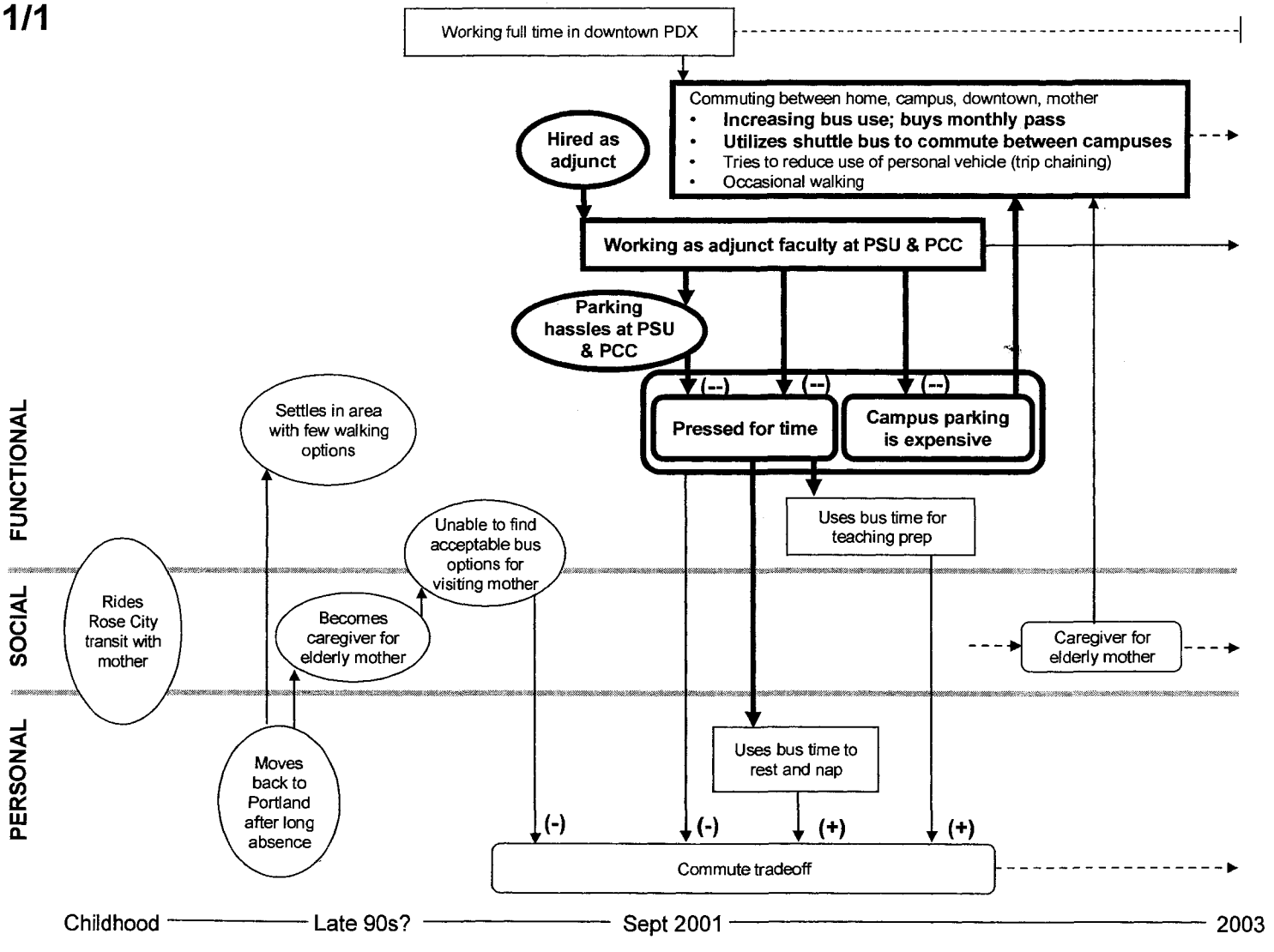
TABLE 27. MAINTENANCE PROCESS SEQUENCES

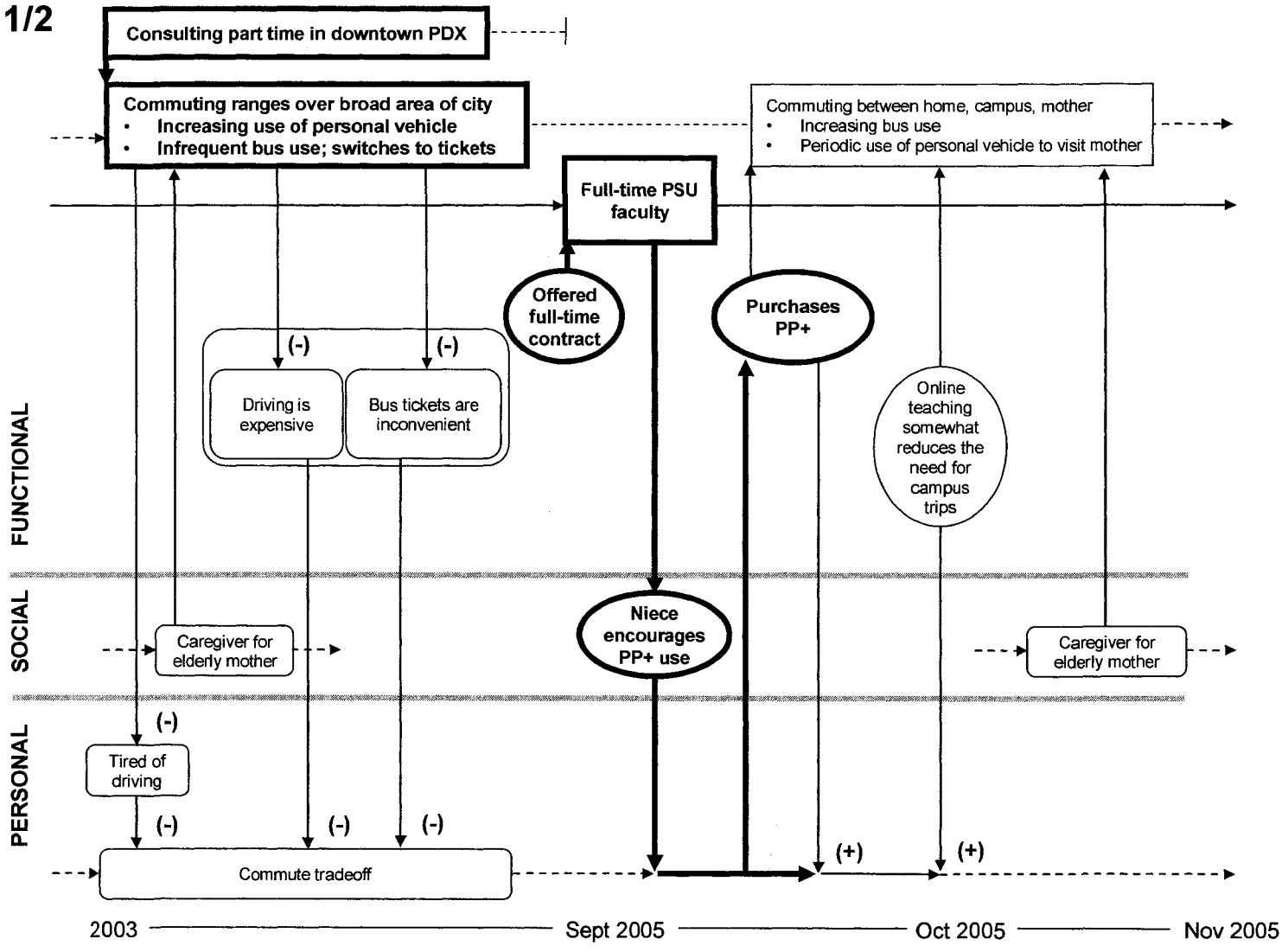
ID	Case	DD	Maintenance Episode	Maintenance Sequence
2	PP+	1/3	Subscribes to Flexcar	EVTM SUB
4	PP+	3/2	Subscribes to Flexcar	EVTM SUB
8	PP+	4/2	Subscribes to Flexcar	EVTM SUB
11	PP+	5/2	Subscribes to Flexcar	EVTM SUB
12	PP+	5/2	Flexcar membership expires	EVTM EXP
19	PP+	8/5	Subscribes to Flexcar	EVTM SUB
23	PP+	14/2	Subscribes to Flexcar	EVTM SUB
30	PP+	18/2	Subscribes to Flexcar	EVTM SUB
32	PP+	18/2	Unsubscribes to Flexcar	EVTM UNS
33	PP+	18/4	Resubscribes to Flexcar	EVTM SUB
37	PP+	4/3	Buys "fixie" commuter bike	EVTM BUY
46	PP+	10/1	Eugene: buys bike	EVTM BUY
54	PP+	14/2	Buys bicycle	EVTM BUY
57	PP+	17/2	Purchases bikes	EVTM BUY
68	WB	20/3	Gets bike refurbished	EVTM FIX BLK SI BLKR
78	WB	21/3	Buys hub gear bike	EVTM BUY
82	WB	21/4	Buys winter biking gear	EVTM BUY
86	WB	21/5	Buys air horn	EVTM BUY
88	WB	22/2	Buys bike	EVTM BUY
92	WB	22/4	Buys rain gear	EVTM BUY
100	WB	23/3	Buys bike	EVTM BUY BLK BLKR
103	WB	23/3	PDX: Buys rain gear	EVTM BUY
107	WB	25/2	Buys fixie	EVTM BUY
114	WB	25/4	Buys biking gear	EVTM BUY BLK BLKR BLK BLKR BLK BLKR
121	WB	26/3	Buys winter bike gear	EVTM BUY
126	WB	27/2	Purchases bike	EVTM BUY SI
131	WB	27/5	Buys series of gloves	EVTM BUY SI BLK
140	WB	33/1	Buys bike	EVTM BUY BLK
143	WB	33/4	Buys another bike	EVTM BUY SI
146	WB	33/6	Buys biking gear	EVTM BUY
147	WB	33/6	Gets bike serviced	EVTM FIX
151	WB	33/7	Buys rain gear	EVTM BUY PRO BUY
153	WB	33/8	Needs gloves	EVTM BUY BLK BLKR BLK
169	PP+	1/2	Purchases PP+	EVTM SUB
171	PP+	3/2	Purchases PP+	EVTM SUB
173	PP+	4/2	Purchases PP+	EVTM SUB
176	PP+	4/3	Lets PP+ expire	EVTM EXP
177	PP+	5/1	Purchases PP+	EVTM SUB
179	PP+	5/2	Tries to return PP+	EVTM UNS BLK
181	PP+	5/2	Lets PP+ expire	EVTM EXP
182	PP+	6/2	Purchases PP+	EVTM SUB

ID	Case	DD	Maintenance Episode	Maintenance Sequence
183	PP+	8/2	Purchases PP+	EVTM SUB
185	PP+	10/3	Purchases PP+	EVTM SUB
187	PP+	10/3	Returns PP+ for refund	EVTM UNS
188	PP+	14/1	Purchases PP+	EVTM SUB
190	PP+	17/2	Purchases PP+	EVTM SUB
192	PP+	18/3	Purchases PP+	EVTM SUB
223	PP+	10/2	Buys car	EVTM BUY
237	PP+	18/2	Buys car	EVTM BUY
238	PP+	18/2	Car dies	EVTM FIX BLK
248	WB	21/2	Car dies	EVTM FIX JUNK
254	WB	23/1	Bought 4WD	EVTM BUY
255	WB	23/1	Sold 4WD	EVTM SELL
265	WB	27/6	Buys car	EVTM BUY
270	WB	31/5	Unable to sell car	EVTM SELL BLK
274	WB	33/2	Sells car	EVTM SELL
276	WB	33/2	Buys car	EVTM BUY

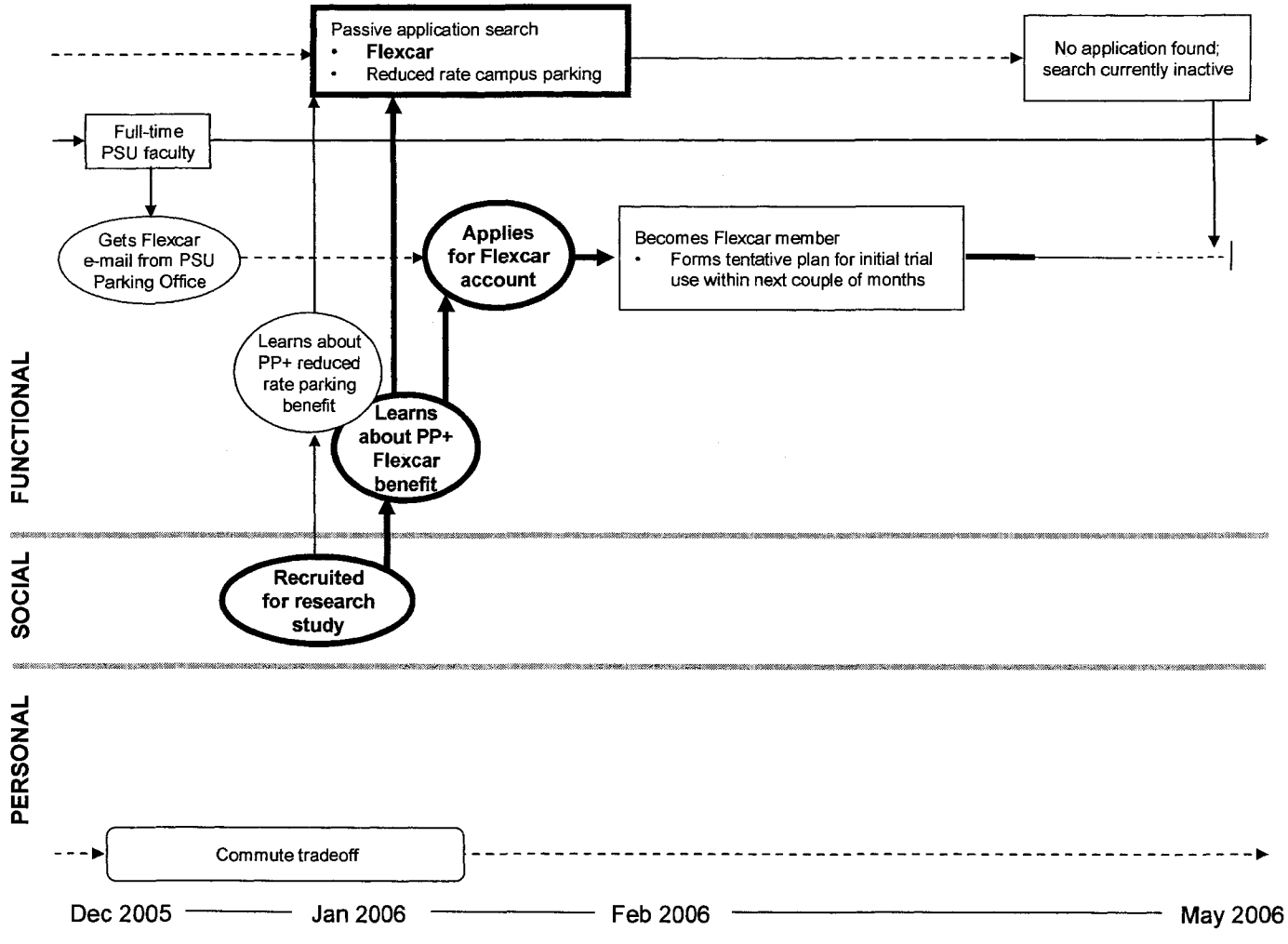
APPENDIX P. DECISION DIAGRAMS

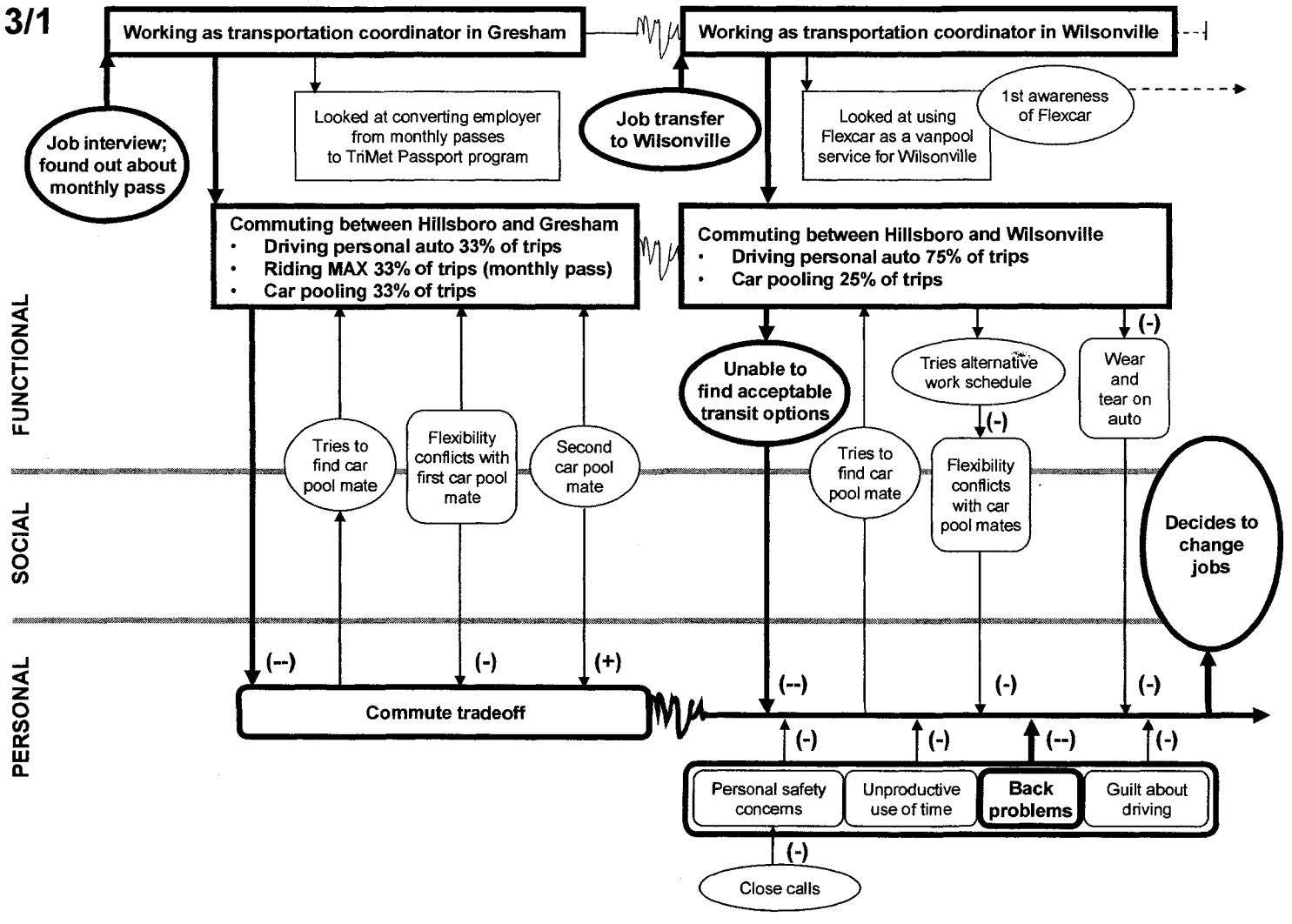
A decision diagram (DD) is a visual display of interactions among streams of issues as a series of decisions unfold over time (Langley, 1999). Its purpose is to depict the time order of events in context, thus making it possible to convert nominal data into ordinal data in preparation for sequence coding. The 32 primary informant interviews yielded a total of 90 pages of DDs: 31 pages from the PP+ case and 59 pages from the WB case. This section lists all of the DDs produced for this study. The notation used in these DDs is described in Figure 24 on Page 104.


Working full time in downtown PDX
Commuting between home, campus, downtown, mother
• Increasing bus use; buys monthly pass
• Utilizes shuttle bus to commute between campuses
• Tries to reduce use of personal vehicle (trip chaining)
• Occasional walking
Hired as adjunct
Working as adjunct faculty at PSU & PCC
Parking hassles at PSU & PCC
(--)
(--)
(--)
Pressed for time
Campus parking is expensive
Uses bus time for teaching prep
Caregiver for elderly mother
Settles in area with few walking options
Unable to find acceptable bus options for visiting mother
Rides Rose City transit with mother
Becomes caregiver for elderly mother
Moves back to Portland after long absence
Uses bus time to rest and nap
(-)
(-)
(+)
(+)
Commute tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
Childhood
Late 90s?
Sept 2001
2003

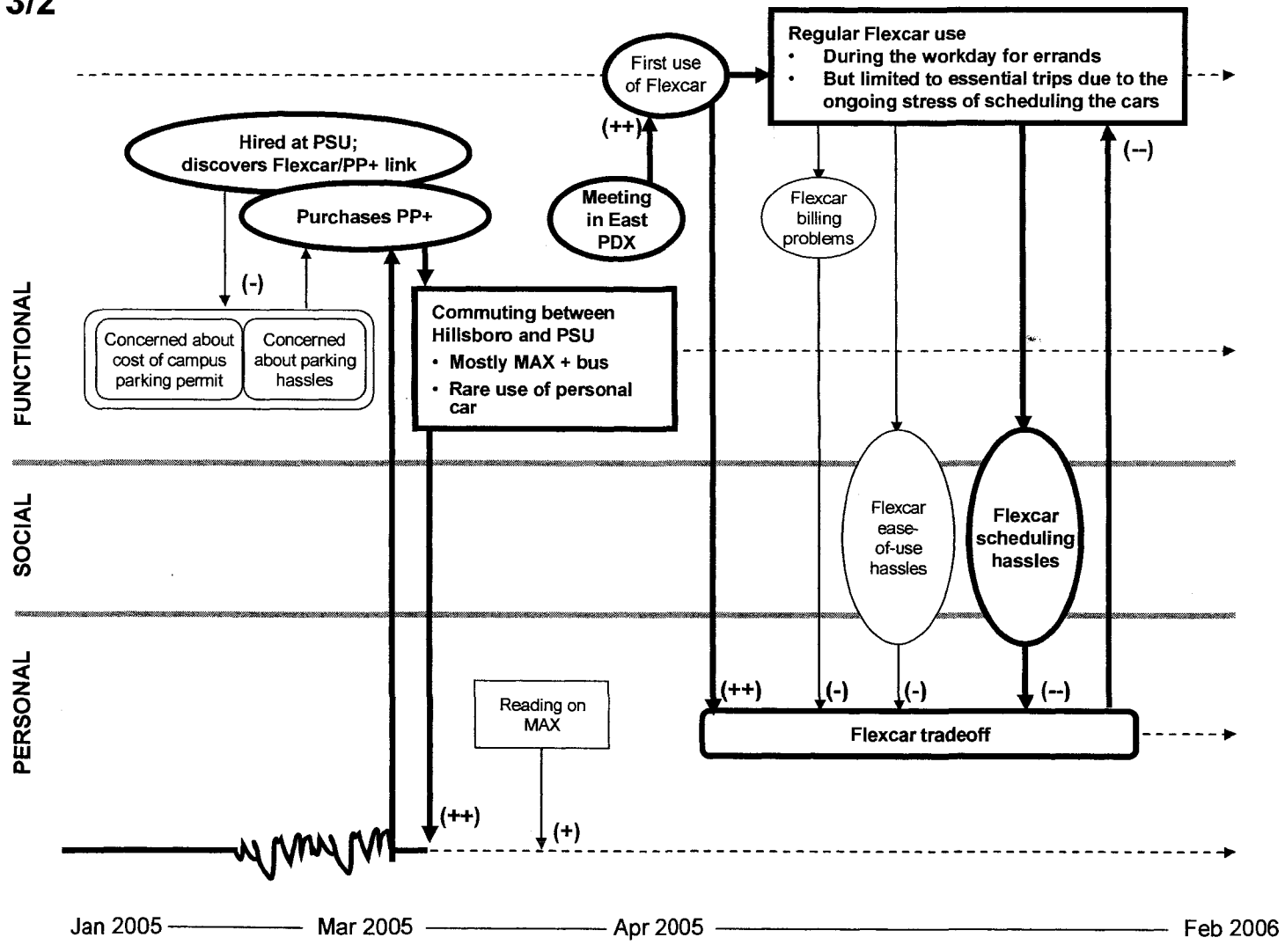

1/2
Consulting part time in downtown PDX
Commuting ranges over broad area of city
• Increasing use of personal vehicle
• Infrequent bus use; switches to tickets
Commuting between home, campus, mother
• Increasing bus use
• Periodic use of personal vehicle to visit mother
Full-time PSU faculty
Offered full-time contract
Purchases PP+
(-)
(-)
Driving is expensive
Bus tickets are inconvenient
Online teaching somewhat reduces the need for campus trips
FUNCTIONAL
SOCIAL
PERSONAL
Caregiver for elderly mother
Niece encourages PP+ use
Caregiver for elderly mother
(-)
Tired of driving
(-)
(-)
(-)
(+)
(+)
Commute tradeoff
2003
Sept 2005
Oct 2005
Nov 2005

1/3

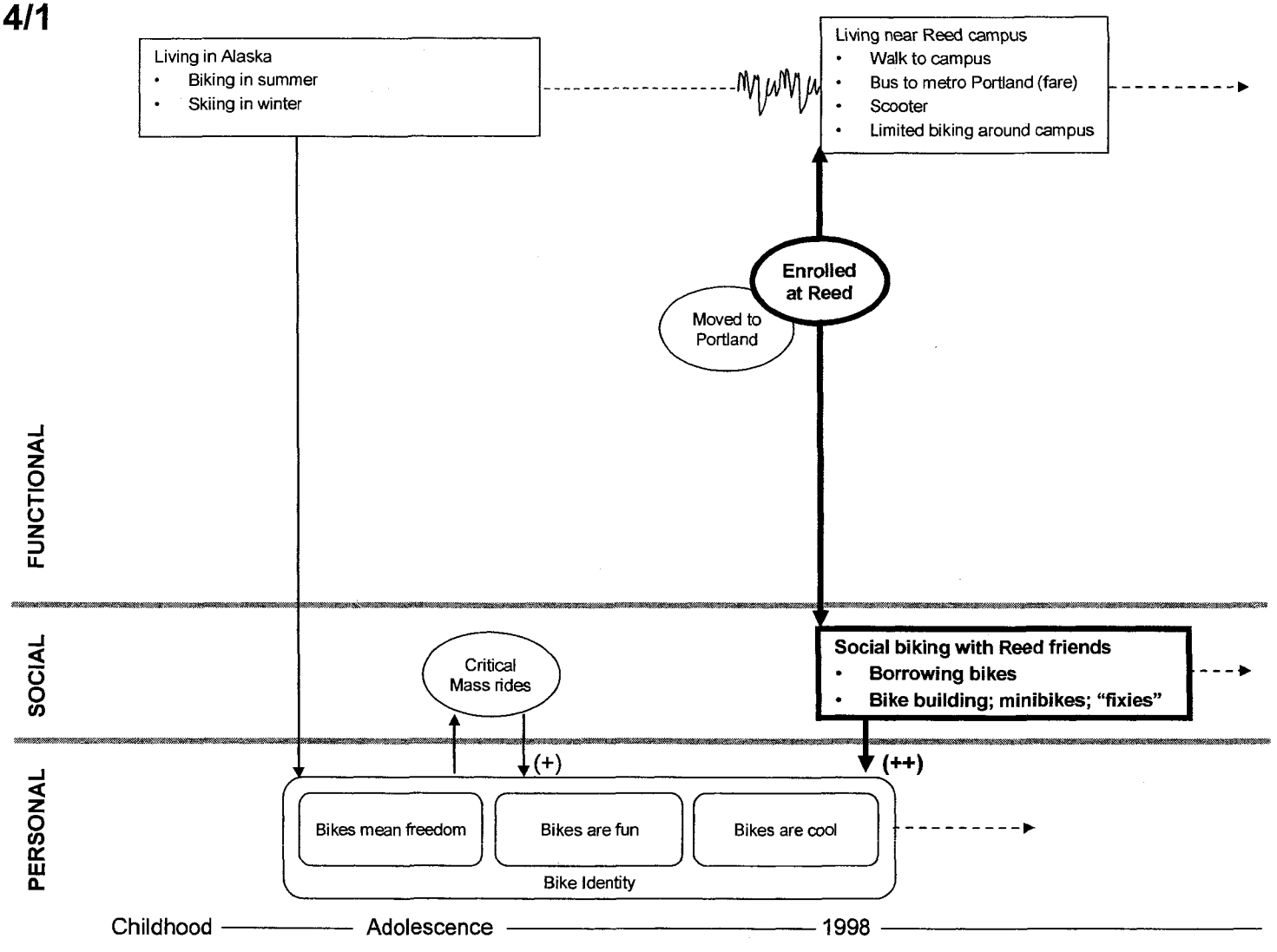

Passive application search
• Flexcar
• Reduced rate campus parking
No application found; search currently inactive
Full-time PSU faculty
Gets Flexcar e-mail from PSU Parking Office
Applies for Flexcar account
Becomes Flexcar member
• Forms tentative plan for initial trial use within next couple of months
Learns about PP+ reduced rate parking benefit
Learns about PP+ Flexcar benefit
Recruited for research study
FUNCTIONAL
SOCIAL
PERSONAL
Commute tradeoff
Dec 2005
Jan 2006
Feb 2006
May 2006


3/1
Working as transportation coordinator in Gresham
Working as transportation coordinator in Wilsonville
Job interview; found out about monthly pass
Looked at converting employer from monthly passes to TriMet Passport program
Job transfer to Wilsonville
Looked at using Flexcar as a vanpool service for Wilsonville
1st awareness of Flexcar
Commuting between Hillsboro and Gresham
• Driving personal auto 33% of trips
• Riding MAX 33% of trips (monthly pass)
• Car pooling 33% of trips
Commuting between Hillsboro and Wilsonville
• Driving personal auto 75% of trips
• Car pooling 25% of trips
FUNCTIONAL
SOCIAL
PERSONAL
Unable to find acceptable transit options
Tries alternative work schedule
Wear and tear on auto
(-)
Tries to find car pool mate
Flexibility conflicts with first car pool mate
Second car pool mate
Tries to find car pool mate
Flexibility conflicts with car pool mates
Decides to change jobs
(--)
(-)
(+)
(--)
(-)
(-)
Commute tradeoff
(-)
(-)
(--)
(-)
Personal safety concerns
Unproductive use of time
Back problems
Guilt about driving
(-)
Close calls
Jan 2000
Nov 2001
Jan 2005

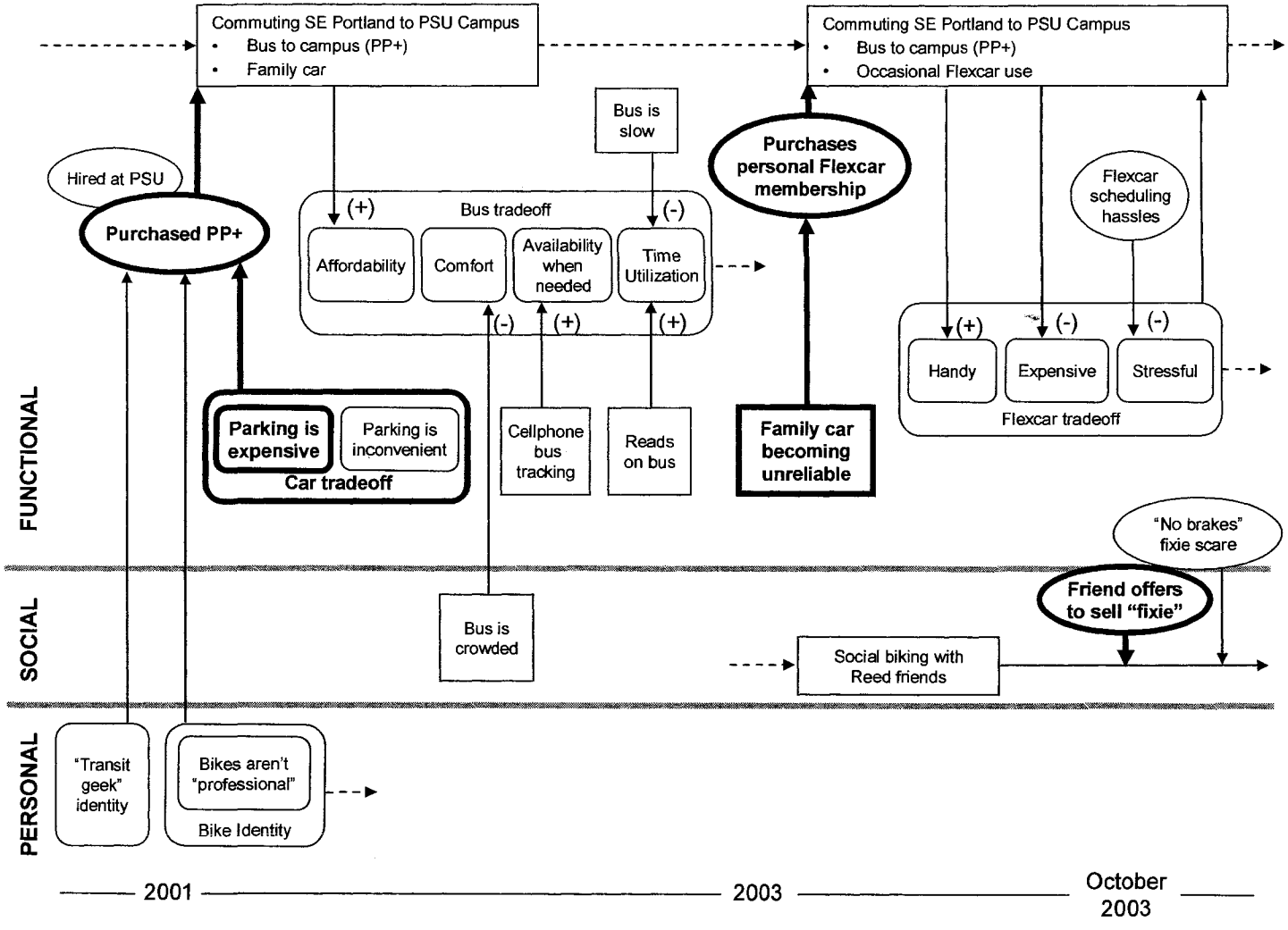
3/2


FUNCTIONAL
SOCIAL
PERSONAL
Hired at PSU; discovers Flexcar/PP+ link
Purchases PP+
First use of Flexcar
Meeting in East PDX
Regular Flexcar use
• During the workday for errands
• But limited to essential trips due to the ongoing stress of scheduling the cars
Flexcar billing problems
(++)
(--)
(-)
Concerned about cost of campus parking permit
Concerned about parking hassles
Commuting between Hillsboro and PSU
• Mostly MAX + bus
• Rare use of personal car
Flexcar ease-of-use hassles
Flexcar scheduling hassles
Reading on MAX
Flexcar tradeoff
(++)
(-)
(-)
(--)
(++)
(+)
Jan 2005
Mar 2005
Apr 2005
Feb 2006

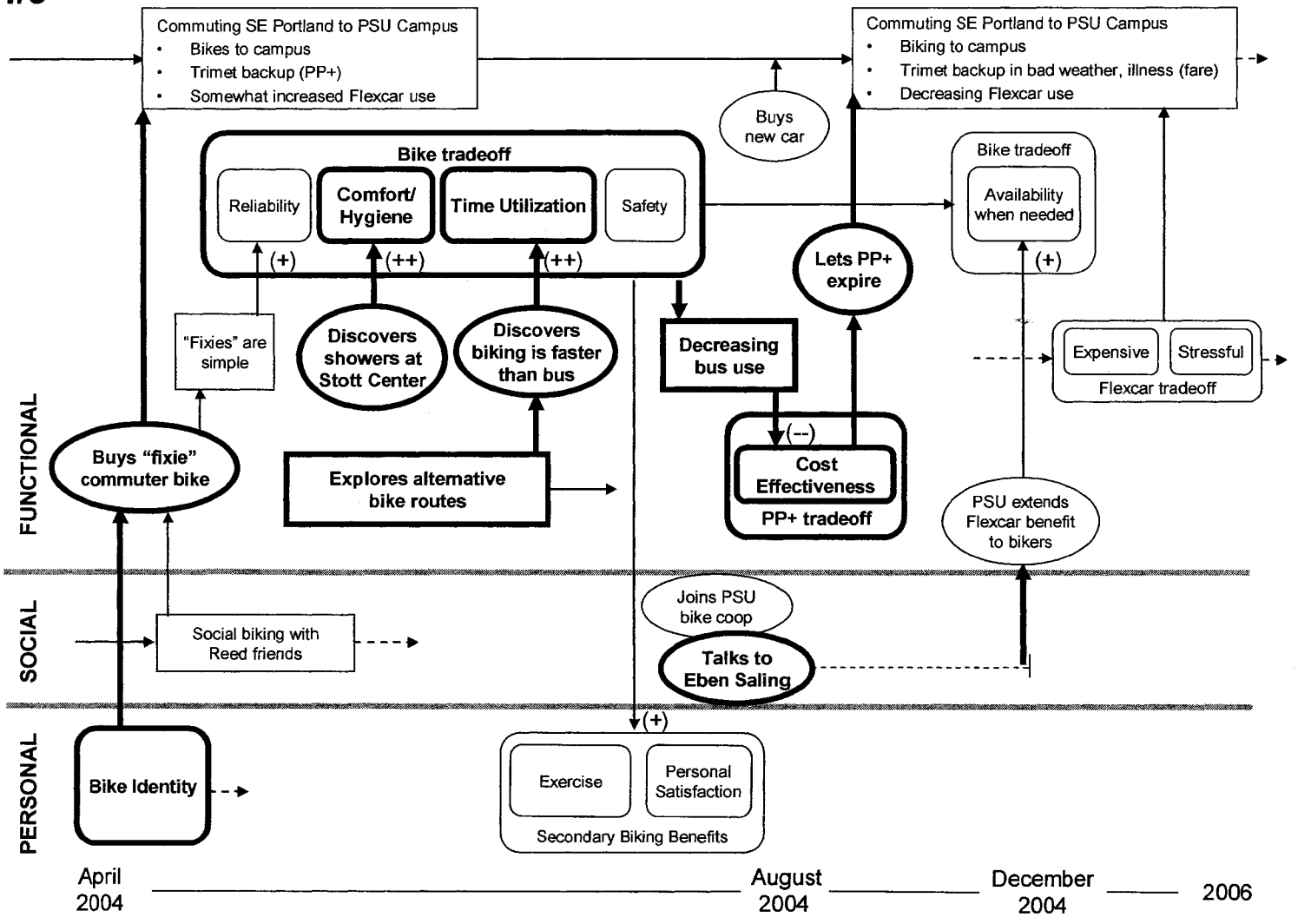
4/1

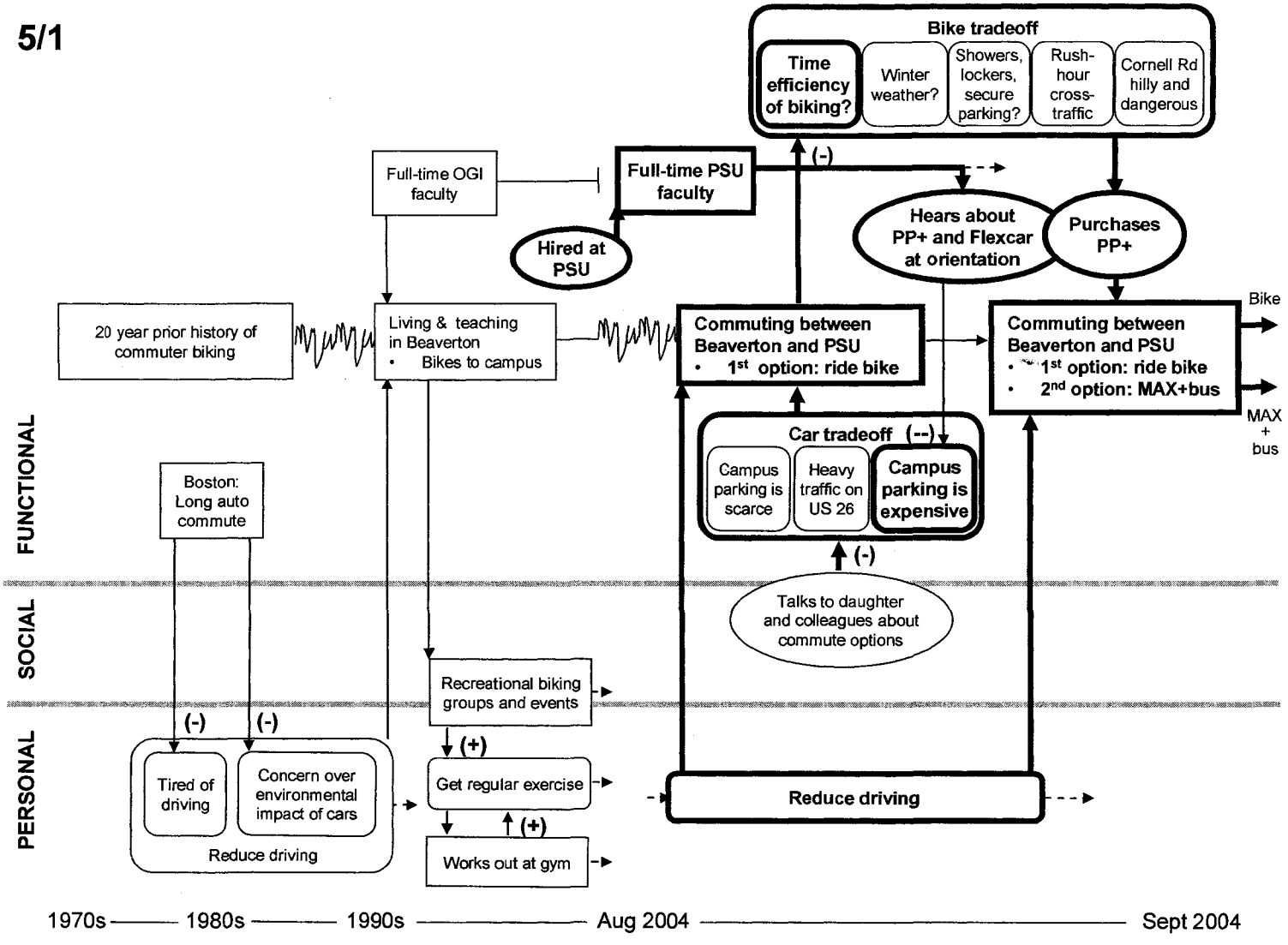

Living in Alaska
• Biking in summer
• Skiing in winter
Living near Reed campus
• Walk to campus
• Bus to metro Portland (fare)
• Scooter
• Limited biking around campus
Enrolled at Reed
Moved to Portland
FUNCTIONAL
SOCIAL
PERSONAL
Critical Mass rides
Social biking with Reed friends
• Borrowing bikes
• Bike building; minibikes; "fixies"
(+)
(++)
Bikes mean freedom
Bikes are fun
Bikes are cool
Bike Identity
Childhood
Adolescence
1998

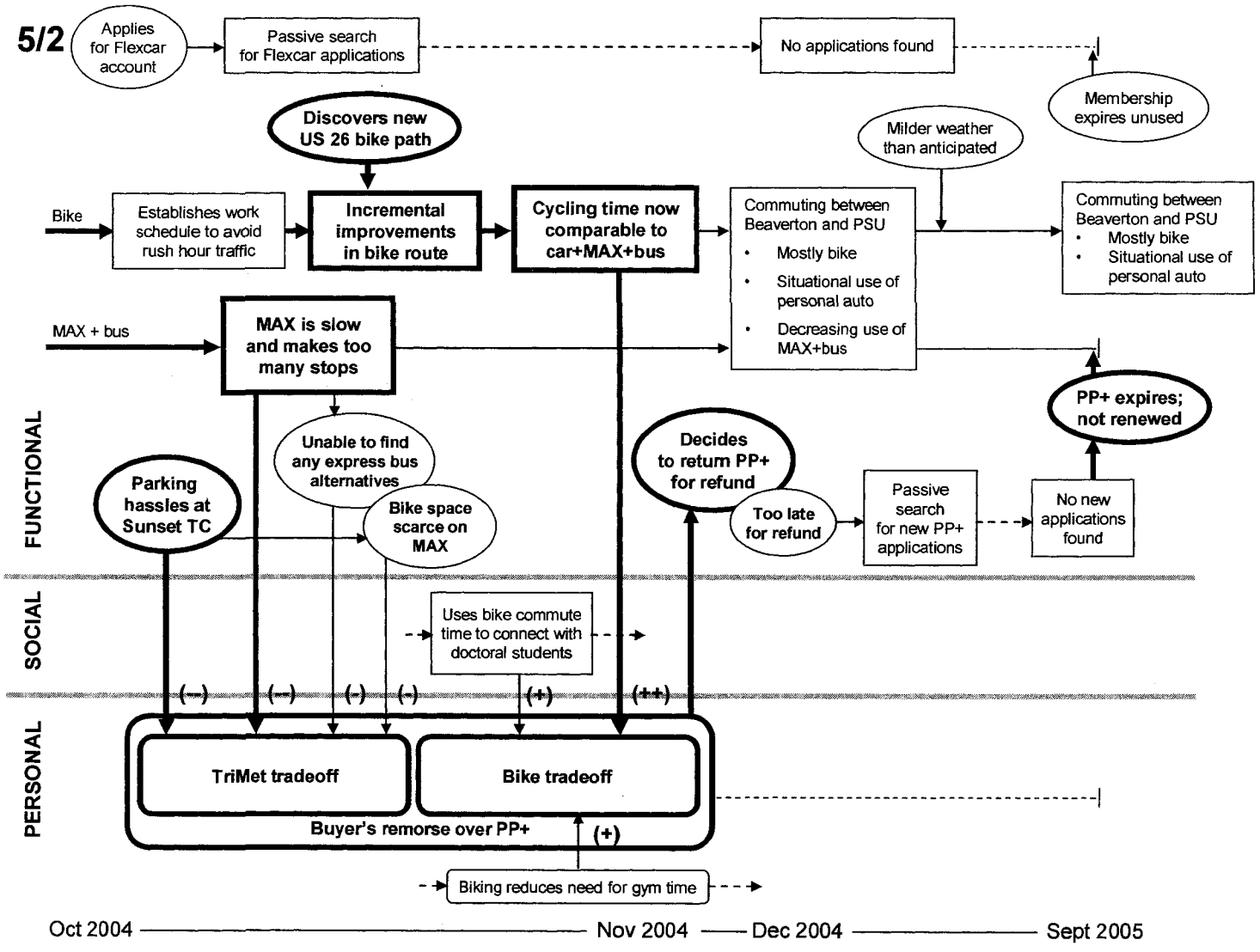
4/2


Commuting SE Portland to PSU Campus
• Bus to campus (PP+)
• Family car
Commuting SE Portland to PSU Campus
• Bus to campus (PP+)
• Occasional Flexcar use
Bus is slow
Purchases personal Flexcar membership
Hired at PSU
Purchased PP+
(+)
Bus tradeoff
(-)
Affordability
Comfort
Availability when needed
Time Utilization
(-)
(+)
(+)
Flexcar scheduling hassles
(+)
(-)
(-)
Handy
Expensive
Stressful
Flexcar tradeoff
Parking is expensive
Parking is inconvenient
Car tradeoff
Cellphone bus tracking
Reads on bus
Family car becoming unreliable
FUNCTIONAL
"No brakes" fixie scare
Friend offers to sell "fixie"
Bus is crowded
Social biking with Reed friends
SOCIAL
"Transit geek" identity
Bikes aren't "professional"
Bike Identity
PERSONAL
2001
2003
October 2003

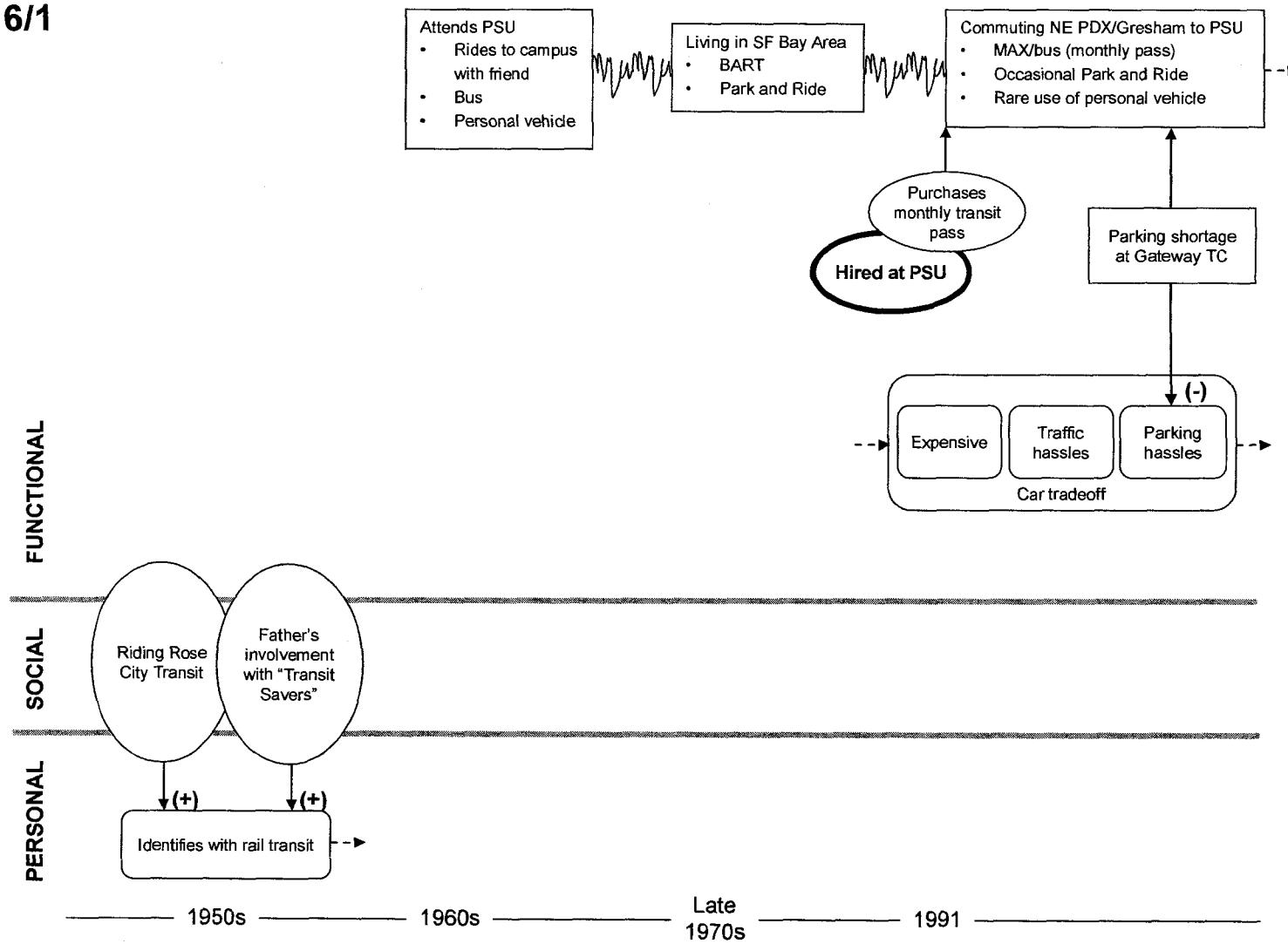
4/3


Commuting SE Portland to PSU Campus
• Bikes to campus
• Trimet backup (PP+)
• Somewhat increased Flexcar use
Commuting SE Portland to PSU Campus
• Biking to campus
• Trimet backup in bad weather, illness (fare)
• Decreasing Flexcar use
Buys new car
Bike tradeoff
Reliability
Comfort/ Hygiene
Time Utilization
Safety
(+)
(++)
(++)
Bike tradeoff
Availability when needed
(+)
Lets PP+ expire
"Fixies" are simple
Discovers showers at Stott Center
Discovers biking is faster than bus
Decreasing bus use
Expensive
Stressful
Flexcar tradeoff
FUNCTIONAL
Buys "fixie" commuter bike
Explores alternative bike routes
(--)
Cost Effectiveness
PP+ tradeoff
PSU extends Flexcar benefit to bikers
SOCIAL
Social biking with Reed friends
Joins PSU bike coop
Talks to Eben Saling
PERSONAL
Bike Identity
(+)
Exercise
Personal Satisfaction
Secondary Biking Benefits
April 2004
August 2004
December 2004
2006

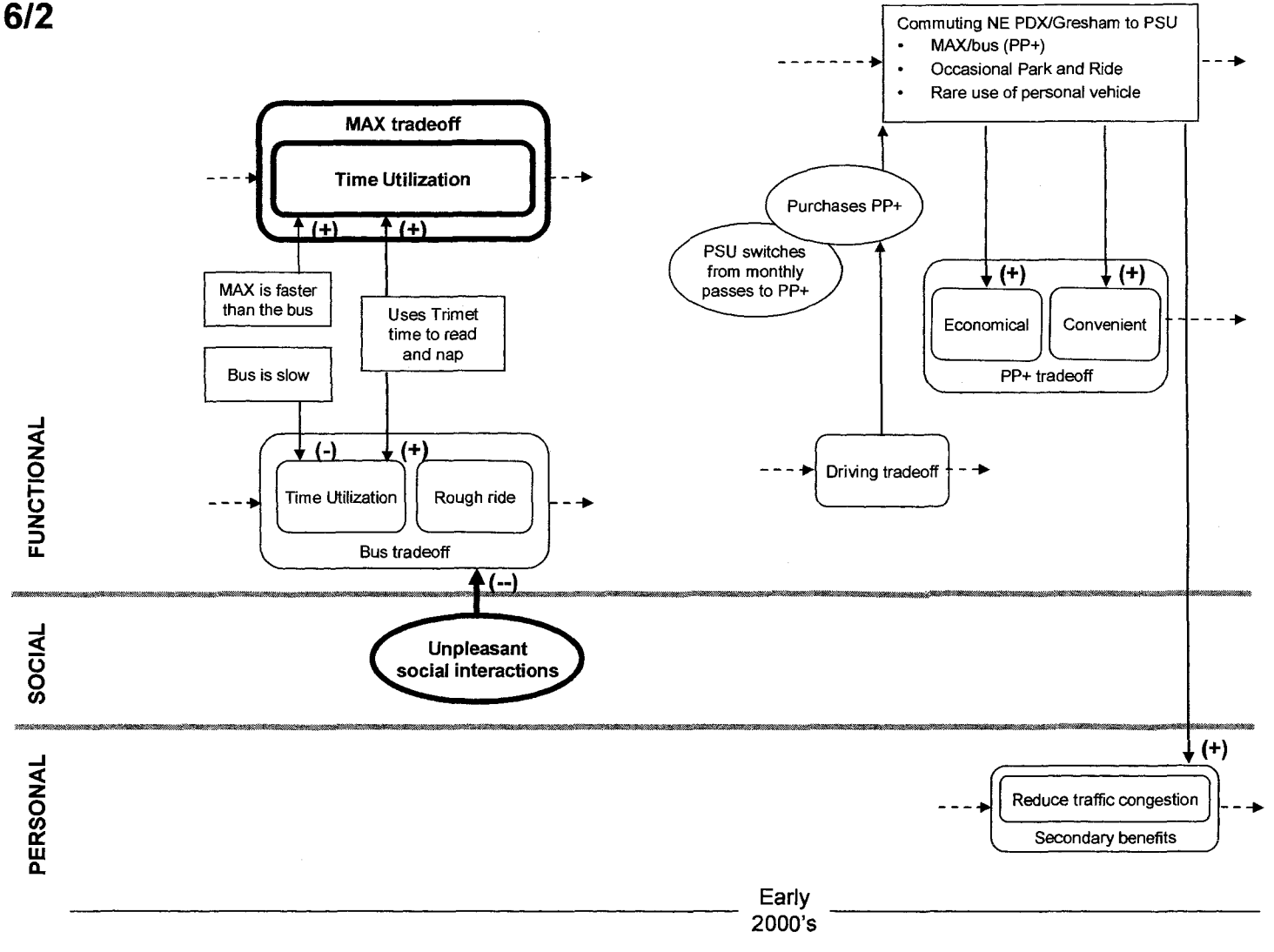

5/1
Bike tradeoff
Time efficiency of biking?
Winter weather?
Showers, lockers, secure parking?
Rush-hour cross-traffic
Cornell Rd hilly and dangerous
Full-time OGI faculty
Full-time PSU faculty
Hired at PSU
(-)
Hears about PP+ and Flexcar at orientation
Purchases PP+
20 year prior history of commuter biking
Living & teaching in Beaverton
• Bikes to campus
Commuting between Beaverton and PSU
• 1st option: ride bike
Commuting between Beaverton and PSU
• 1st option: ride bike
• 2nd option: MAX+bus
Bike
MAX + bus
Car tradeoff (--)
Campus parking is scarce
Heavy traffic on US 26
Campus parking is expensive
(-)
Talks to daughter and colleagues about commute options
Boston: Long auto commute
FUNCTIONAL
SOCIAL
PERSONAL
Recreational biking groups and events
(-)
(-)
(+)
Tired of driving
Concern over environmental impact of cars
Get regular exercise
(+)
Reduce driving
Works out at gym
Reduce driving
1970s
1980s
1990s
Aug 2004
Sept 2004


5/2
Applies for Flexcar account
Passive search for Flexcar applications
No applications found
Membership expires unused
Discovers new US 26 bike path
Milder weather than anticipated
Bike
Establishes work schedule to avoid rush hour traffic
Incremental improvements in bike route
Cycling time now comparable to car+MAX+bus
Commuting between Beaverton and PSU
• Mostly bike
• Situational use of personal auto
• Decreasing use of MAX+bus
Commuting between Beaverton and PSU
• Mostly bike
• Situational use of personal auto
MAX + bus
MAX is slow and makes too many stops
PP+ expires; not renewed
FUNCTIONAL
Unable to find any express bus alternatives
Decides to return PP+ for refund
Parking hassles at Sunset TC
Bike space scarce on MAX
Too late for refund
Passive search for new PP+ applications
No new applications found
SOCIAL
Uses bike commute time to connect with doctoral students
(--)
(--)
(-)
(-)
(+)
(++)
PERSONAL
TriMet tradeoff
Bike tradeoff
Buyer's remorse over PP+
(+)
Biking reduces need for gym time
Oct 2004
Nov 2004
Dec 2004
Sept 2005

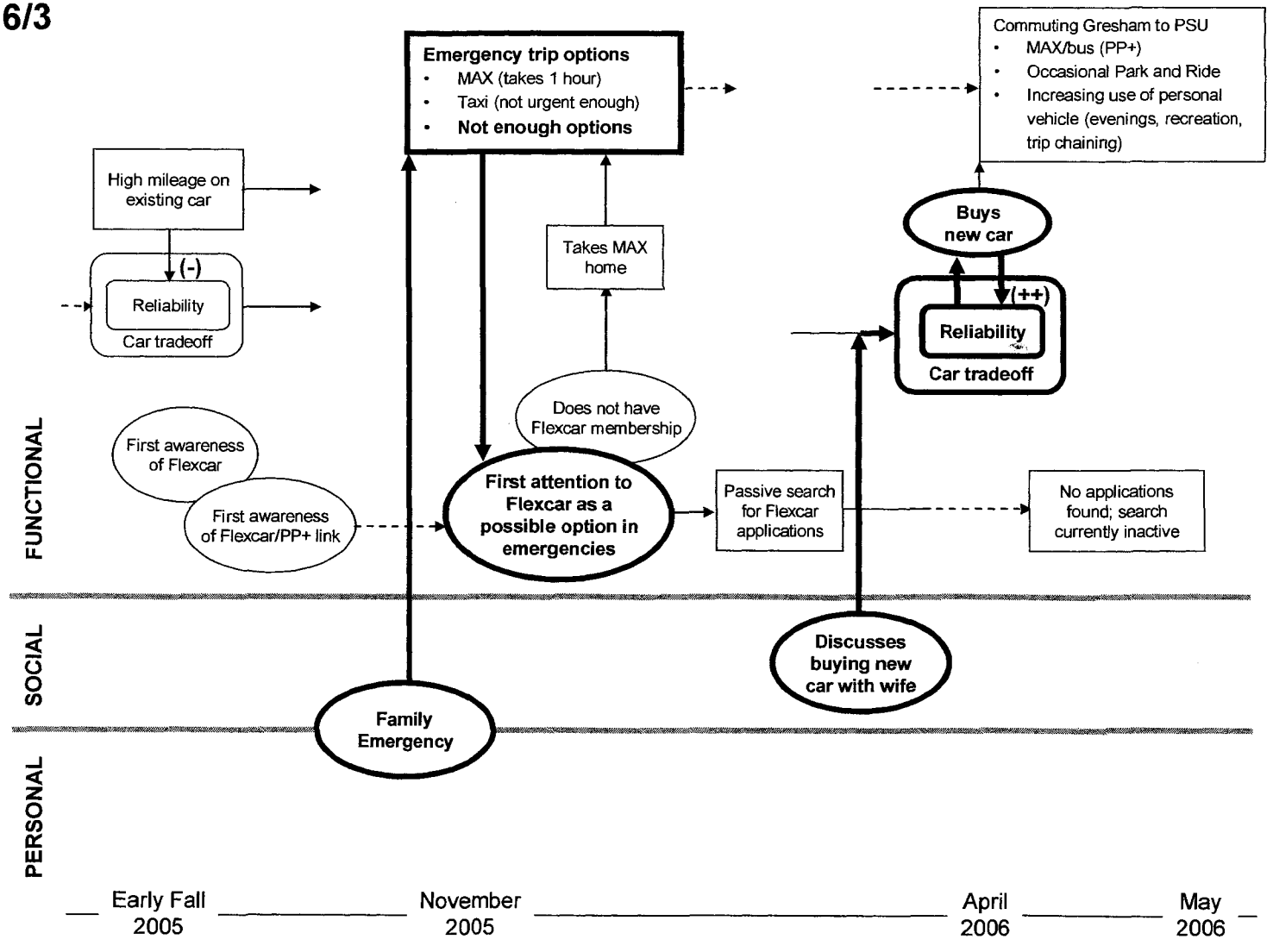
(400)


Attends PSU
• Rides to campus with friend
• Bus
• Personal vehicle
Living in SF Bay Area
• BART
• Park and Ride
Commuting NE PDX/Gresham to PSU
• MAX/bus (monthly pass)
• Occasional Park and Ride
• Rare use of personal vehicle
Purchases monthly transit pass
Hired at PSU
Parking shortage at Gateway TC
(-)
Expensive
Traffic hassles
Parking hassles
Car tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
Riding Rose City Transit
Father's involvement with "Transit Savers"
(+)
(+)
Identifies with rail transit
1950s
1960s
Late 1970s
1991

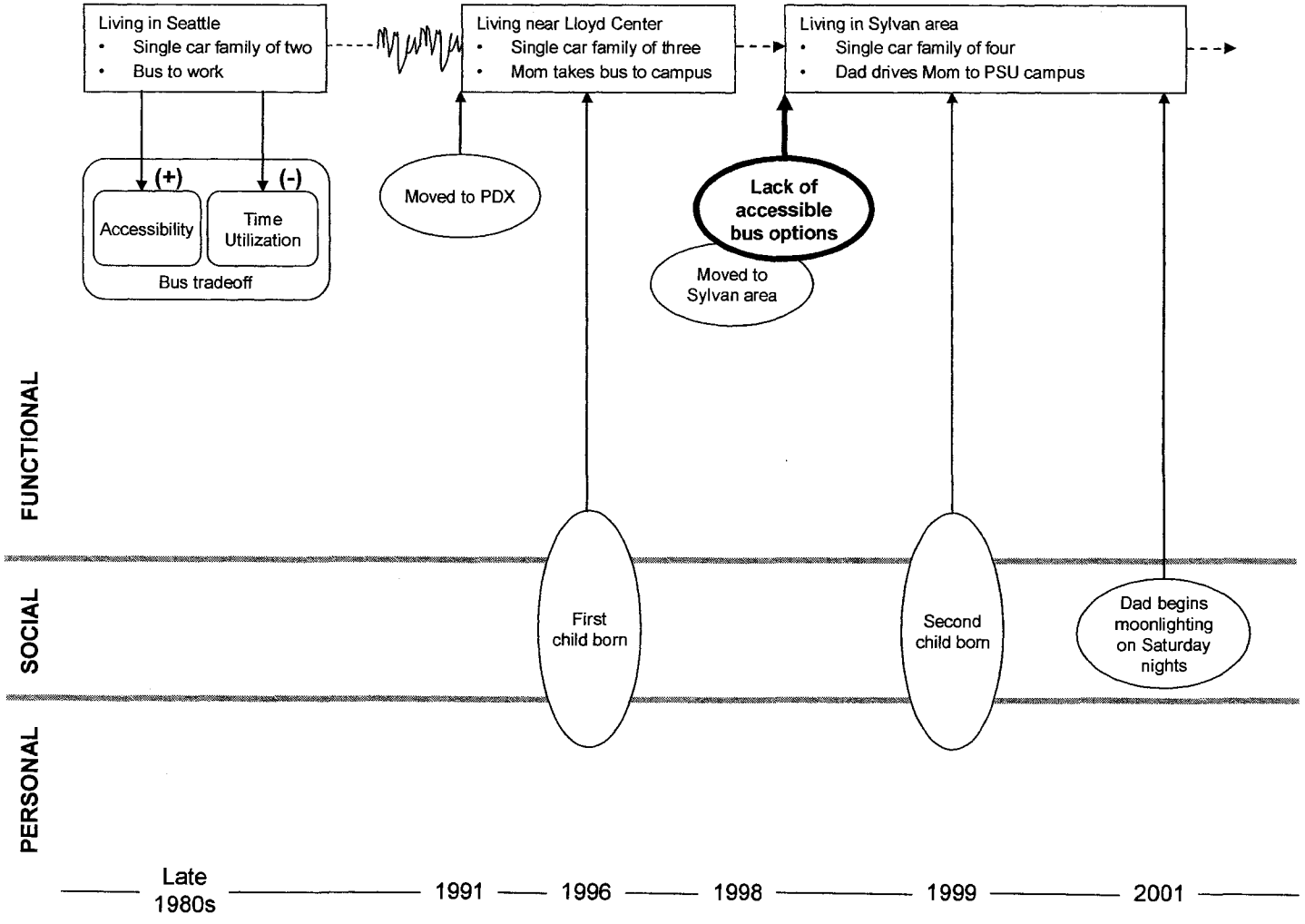
6/2


Commuting NE PDX/Gresham to PSU
• MAX/bus (PP+)
• Occasional Park and Ride
• Rare use of personal vehicle
MAX tradeoff
Time Utilization
(+)
(+)
MAX is faster than the bus
Uses Trimet time to read and nap
Bus is slow
Purchases PP+
PSU switches from monthly passes to PP+
(+)
(+)
Economical
Convenient
PP+ tradeoff
(-)
(+)
Time Utilization
Rough ride
Bus tradeoff
Driving tradeoff
(--)
Unpleasant social interactions
FUNCTIONAL
SOCIAL
PERSONAL
(+)
Reduce traffic congestion
Secondary benefits
Early 2000's

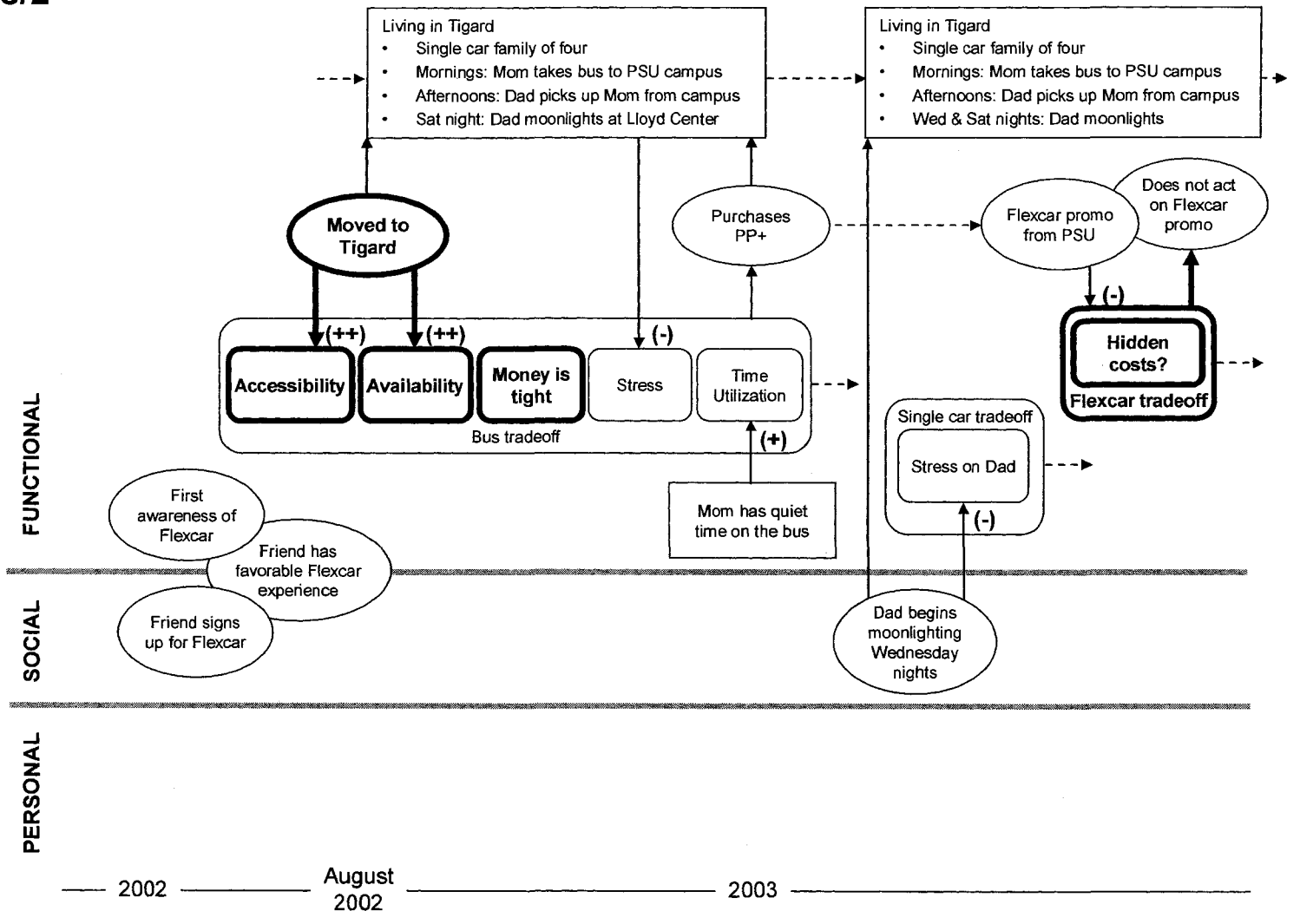
(402)

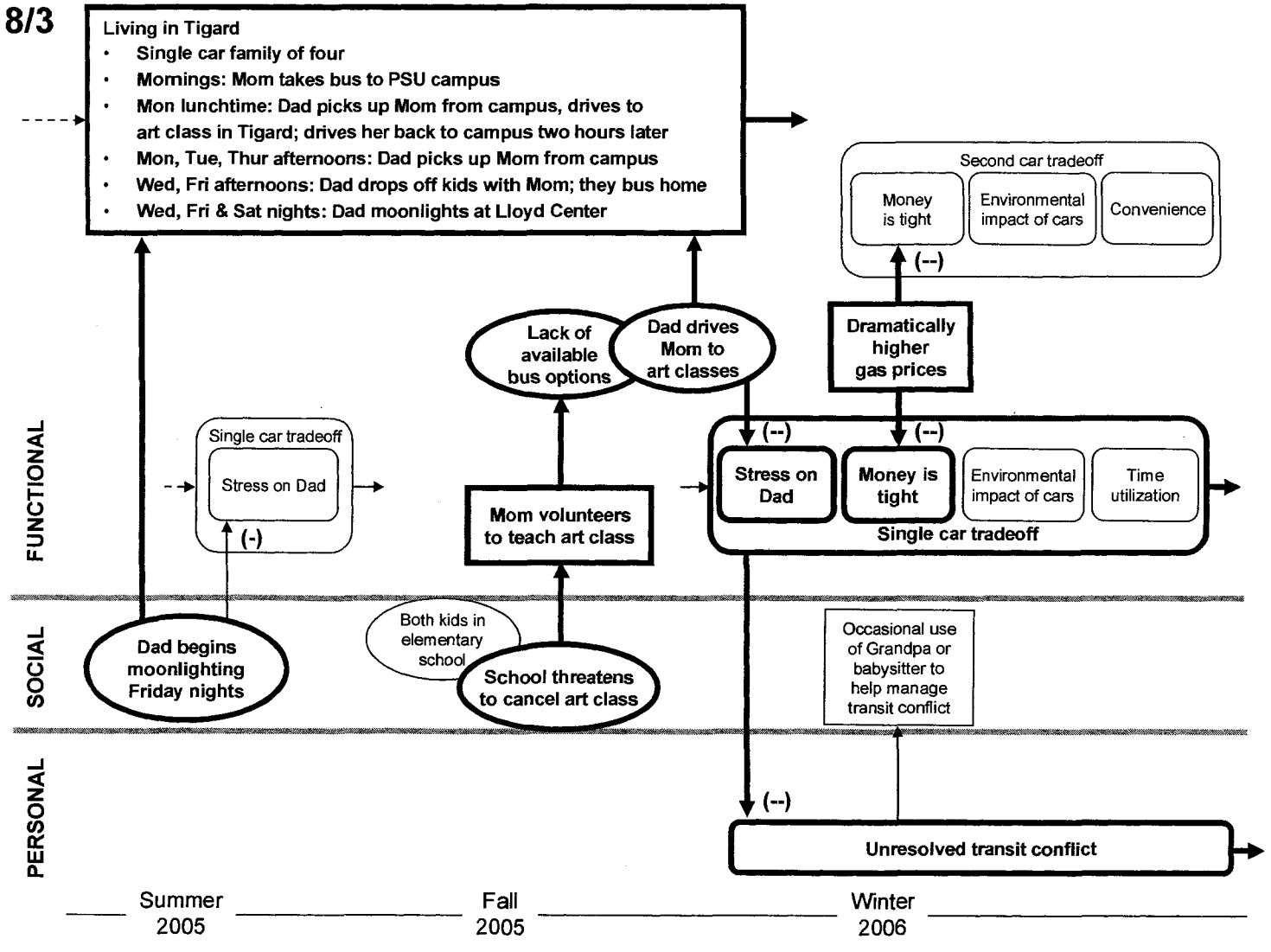

Emergency trip options
• MAX (takes 1 hour)
• Taxi (not urgent enough)
• Not enough options
Commuting Gresham to PSU
• MAX/bus (PP+)
• Occasional Park and Ride
• Increasing use of personal vehicle (evenings, recreation, trip chaining)
High mileage on existing car
(-)
Reliability
Car tradeoff
Takes MAX home
Buys new car
(++)
Reliability
Car tradeoff
Does not have Flexcar membership
First awareness of Flexcar
First awareness of Flexcar/PP+ link
First attention to Flexcar as a possible option in emergencies
Passive search for Flexcar applications
No applications found; search currently inactive
Discusses buying new car with wife
Family Emergency
FUNCTIONAL
SOCIAL
PERSONAL
Early Fall 2005
November 2005
April 2006
May 2006

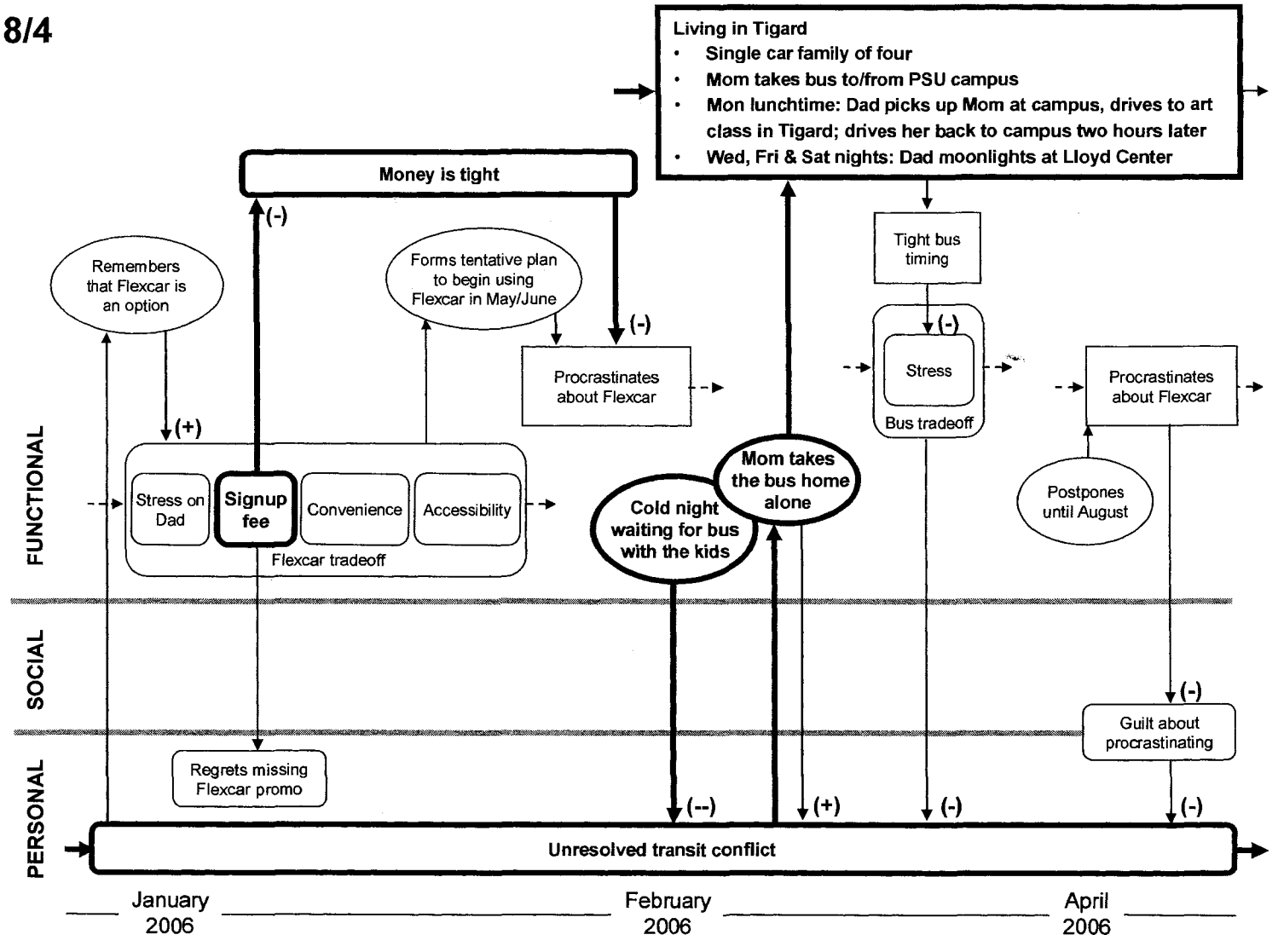
8/1


Living in Seattle
• Single car family of two
• Bus to work
Living near Lloyd Center
• Single car family of three
• Mom takes bus to campus
Living in Sylvan area
• Single car family of four
• Dad drives Mom to PSU campus
(+)
(-)
Accessibility
Time Utilization
Bus tradeoff
Moved to PDX
Lack of accessible bus options
Moved to Sylvan area
FUNCTIONAL
SOCIAL
PERSONAL
First child born
Second child born
Dad begins moonlighting on Saturday nights
Late 1980s
1991
1996
1998
1999
2001

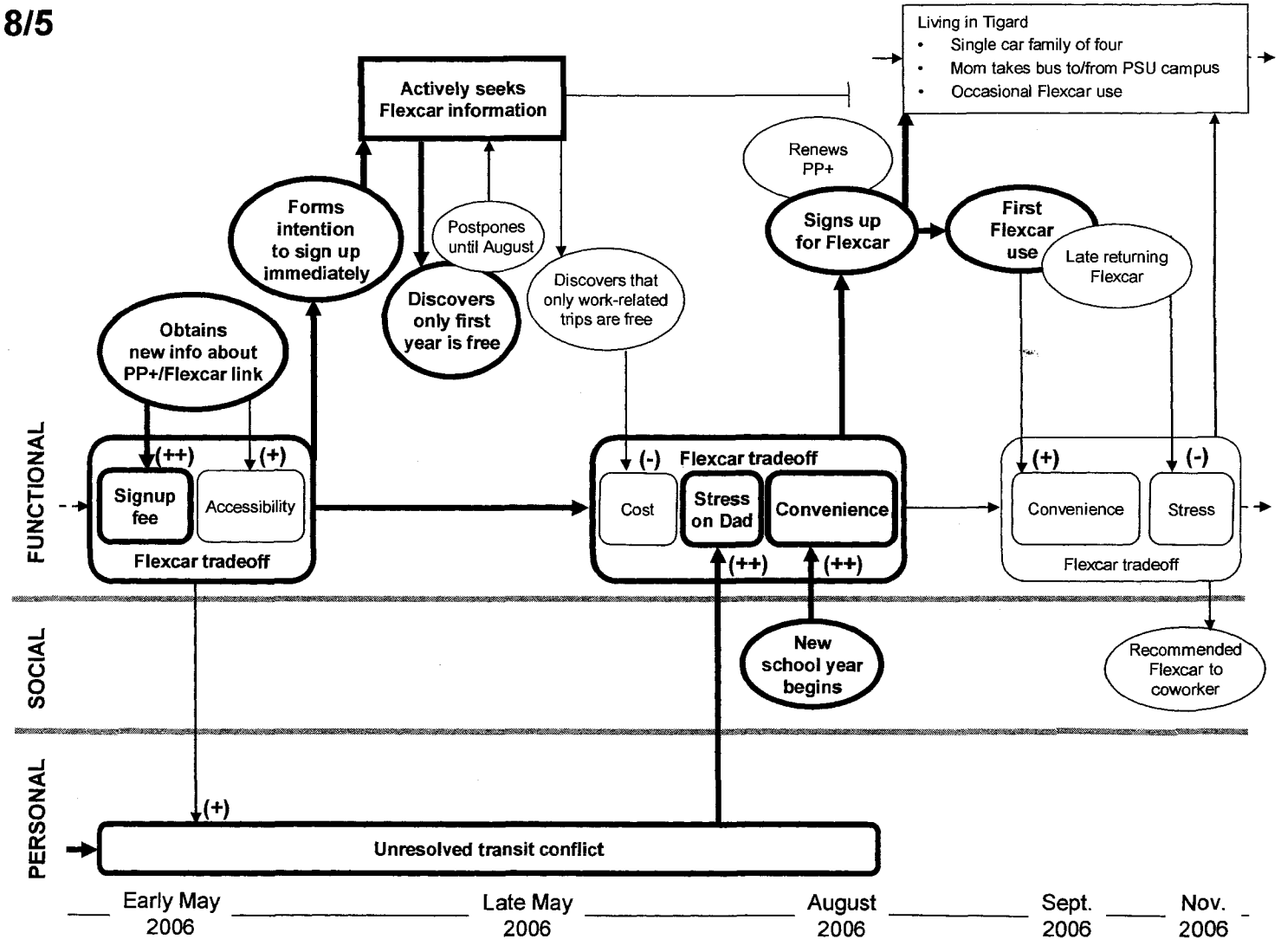
(404)


Living in Tigard
• Single car family of four
• Mornings: Mom takes bus to PSU campus
• Afternoons: Dad picks up Mom from campus
• Sat night: Dad moonlights at Lloyd Center
Living in Tigard
• Single car family of four
• Mornings: Mom takes bus to PSU campus
• Afternoons: Dad picks up Mom from campus
• Wed & Sat nights: Dad moonlights
Moved to Tigard
Purchases PP+
Flexcar promo from PSU
Does not act on Flexcar promo
(++)
(++)
(-)
Accessibility
Availability
Money is tight
Stress
Time Utilization
Bus tradeoff
(+)
(-)
Hidden costs?
Flexcar tradeoff
Single car tradeoff
Stress on Dad
(-)
First awareness of Flexcar
Friend has favorable Flexcar experience
Friend signs up for Flexcar
Mom has quiet time on the bus
Dad begins moonlighting Wednesday nights
FUNCTIONAL
SOCIAL
PERSONAL
2002
August 2002
2003

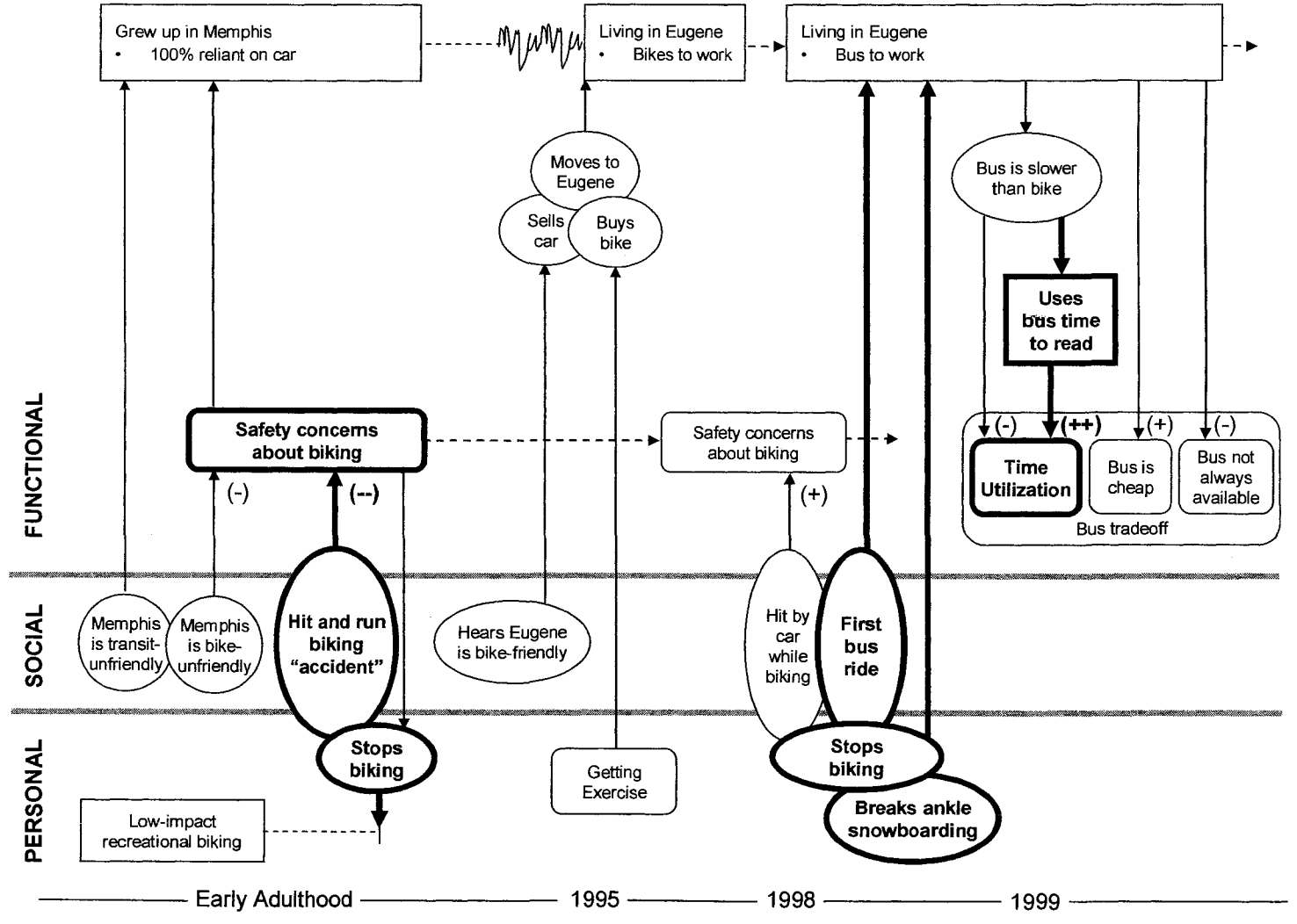

8/3
Living in Tigard
• Single car family of four
• Mornings: Mom takes bus to PSU campus
• Mon lunchtime: Dad picks up Mom from campus, drives to art class in Tigard; drives her back to campus two hours later
• Mon, Tue, Thur afternoons: Dad picks up Mom from campus
• Wed, Fri afternoons: Dad drops off kids with Mom; they bus home
• Wed, Fri & Sat nights: Dad moonlights at Lloyd Center
Second car tradeoff
Money is tight
Environmental impact of cars
Convenience
(--)
Dramatically higher gas prices
Lack of available bus options
Dad drives Mom to art classes
Single car tradeoff
Stress on Dad
(-)
Mom volunteers to teach art class
(--)
(--)
Stress on Dad
Money is tight
Environmental impact of cars
Time utilization
Single car tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
Dad begins moonlighting Friday nights
Both kids in elementary school
School threatens to cancel art class
Occasional use of Grandpa or babysitter to help manage transit conflict
(--)
Unresolved transit conflict
Summer 2005
Fall 2005
Winter 2006


Living in Tigard
• Single car family of four
• Mom takes bus to/from PSU campus
• Mon lunchtime: Dad picks up Mom at campus, drives to art class in Tigard; drives her back to campus two hours later
• Wed, Fri & Sat nights: Dad moonlights at Lloyd Center
Money is tight
(-)
Remembers that Flexcar is an option
Forms tentative plan to begin using Flexcar in May/June
(-)
Procrastinates about Flexcar
Tight bus timing
(-)
Stress
Bus tradeoff
Procrastinates about Flexcar
(+)
Stress on Dad
Signup fee
Convenience
Accessibility
Flexcar tradeoff
Cold night waiting for bus with the kids
Mom takes the bus home alone
Postpones until August
FUNCTIONAL
SOCIAL
PERSONAL
Guilt about procrastinating
(-)
Regrets missing Flexcar promo
(--)
(+)
(-)
(-)
Unresolved transit conflict
January 2006
February 2006
April 2006

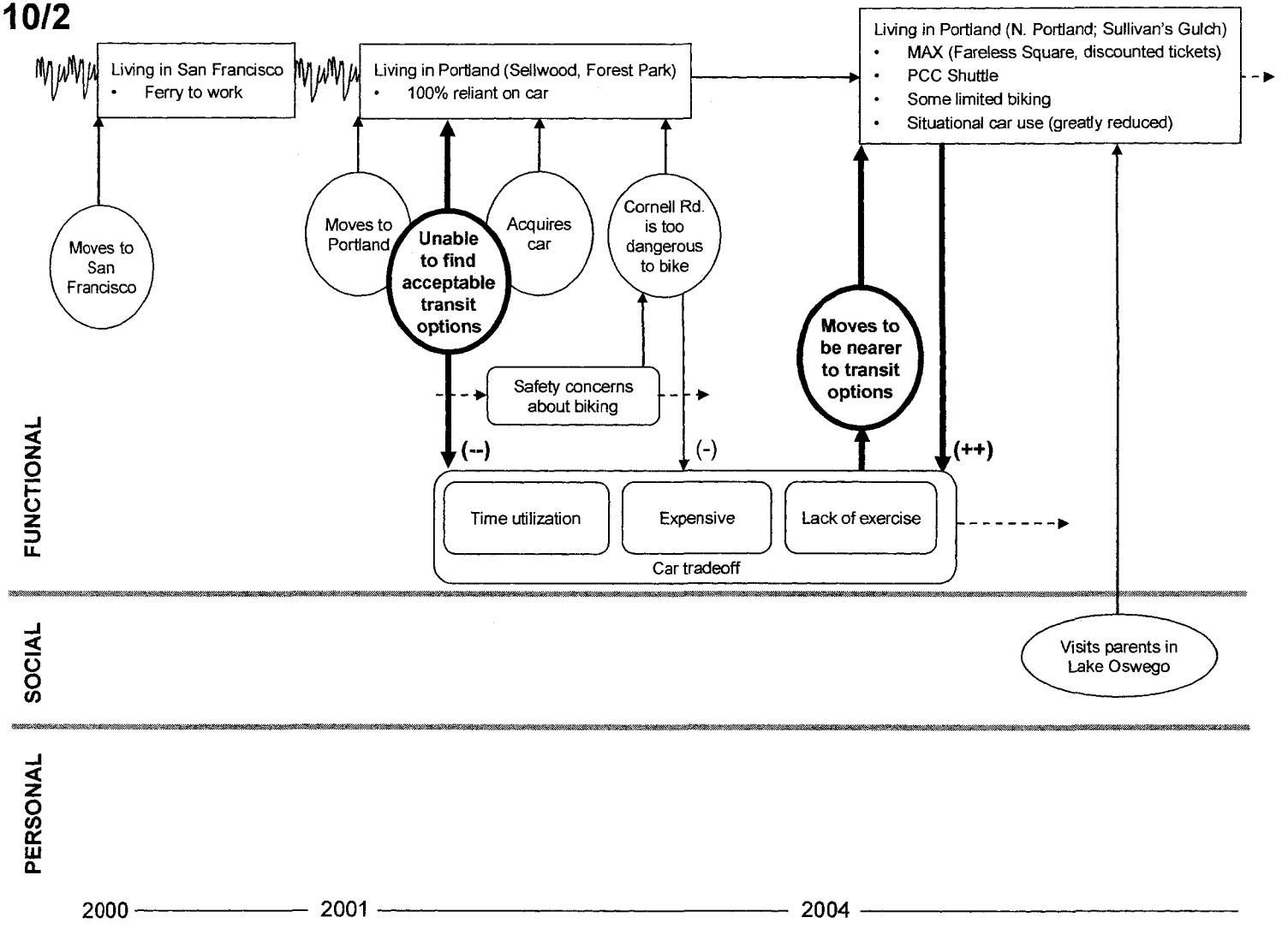
8/5

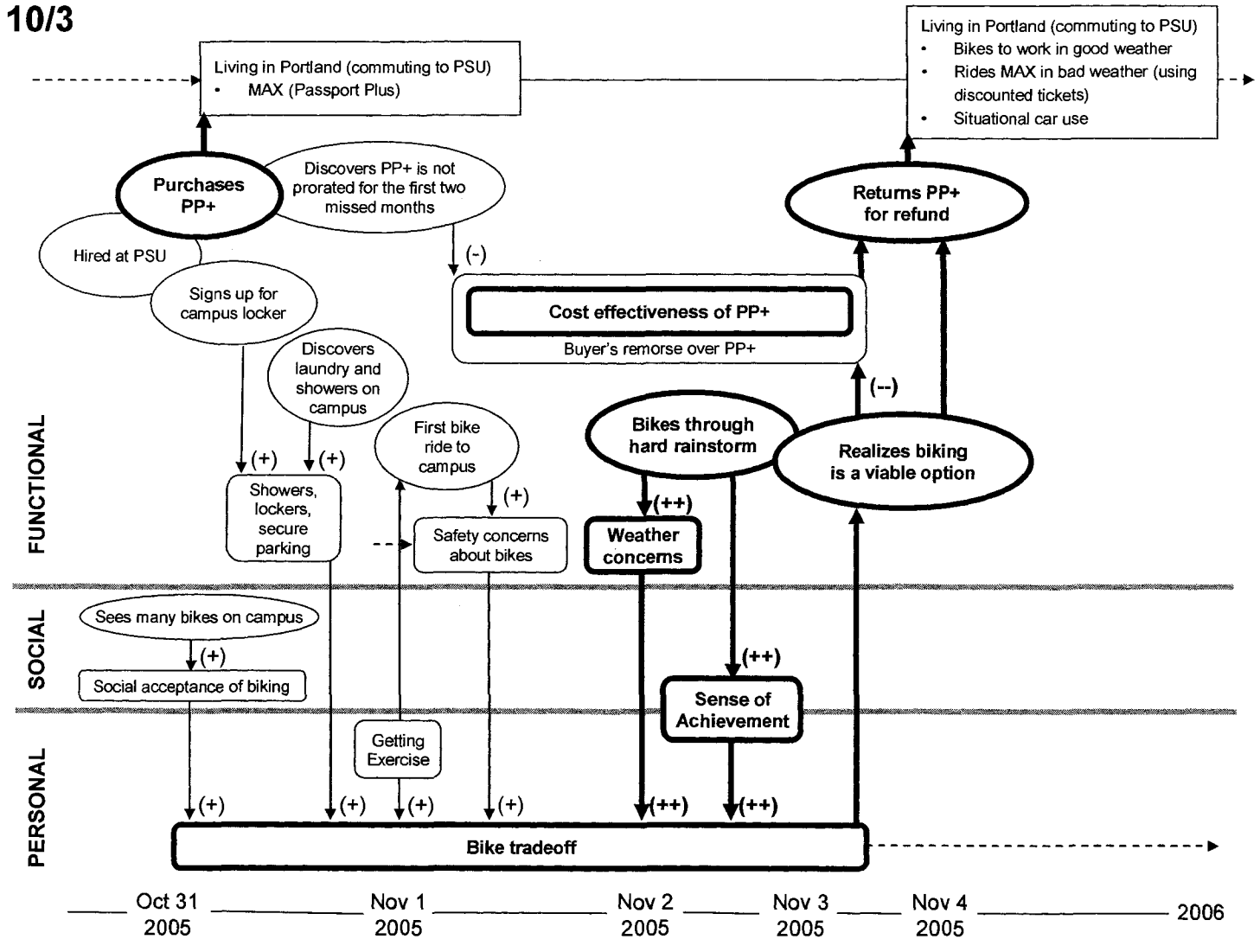

Living in Tigard
• Single car family of four
• Mom takes bus to/from PSU campus
• Occasional Flexcar use
Actively seeks Flexcar information
Renews PP+
Forms intention to sign up immediately
Postpones until August
Signs up for Flexcar
First Flexcar use
Late returning Flexcar
Discovers only first year is free
Discovers that only work-related trips are free
Obtains new info about PP+/Flexcar link
FUNCTIONAL
(++)
(+)
Signup fee
Accessibility
Flexcar tradeoff
(-)
Flexcar tradeoff
Cost
Stress on Dad
Convenience
(++)
(++)
(+)
(-)
Convenience
Stress
Flexcar tradeoff
SOCIAL
New school year begins
Recommended Flexcar to coworker
PERSONAL
(+)
Unresolved transit conflict
Early May 2006
Late May 2006
August 2006
Sept. 2006
Nov. 2006

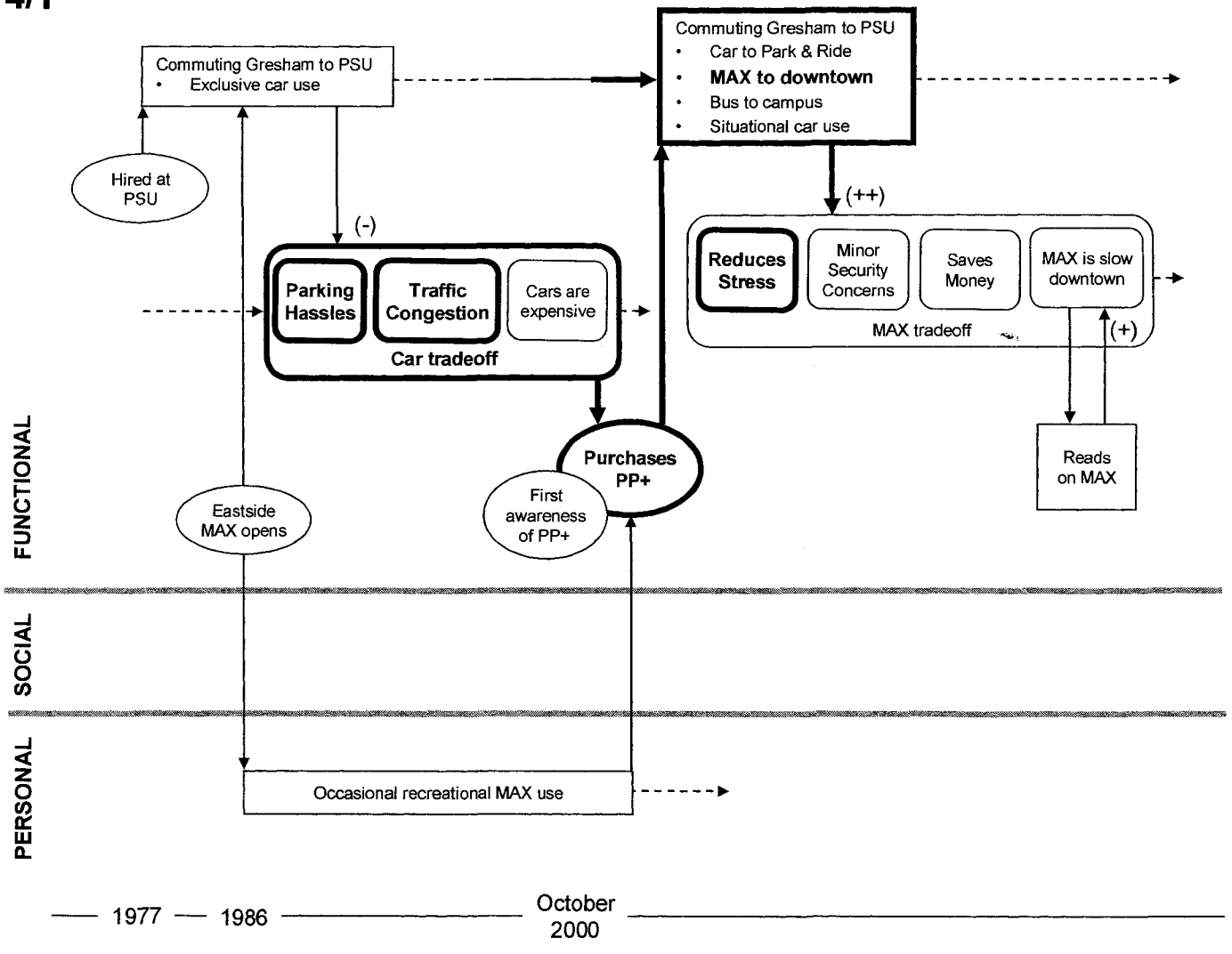
10/1

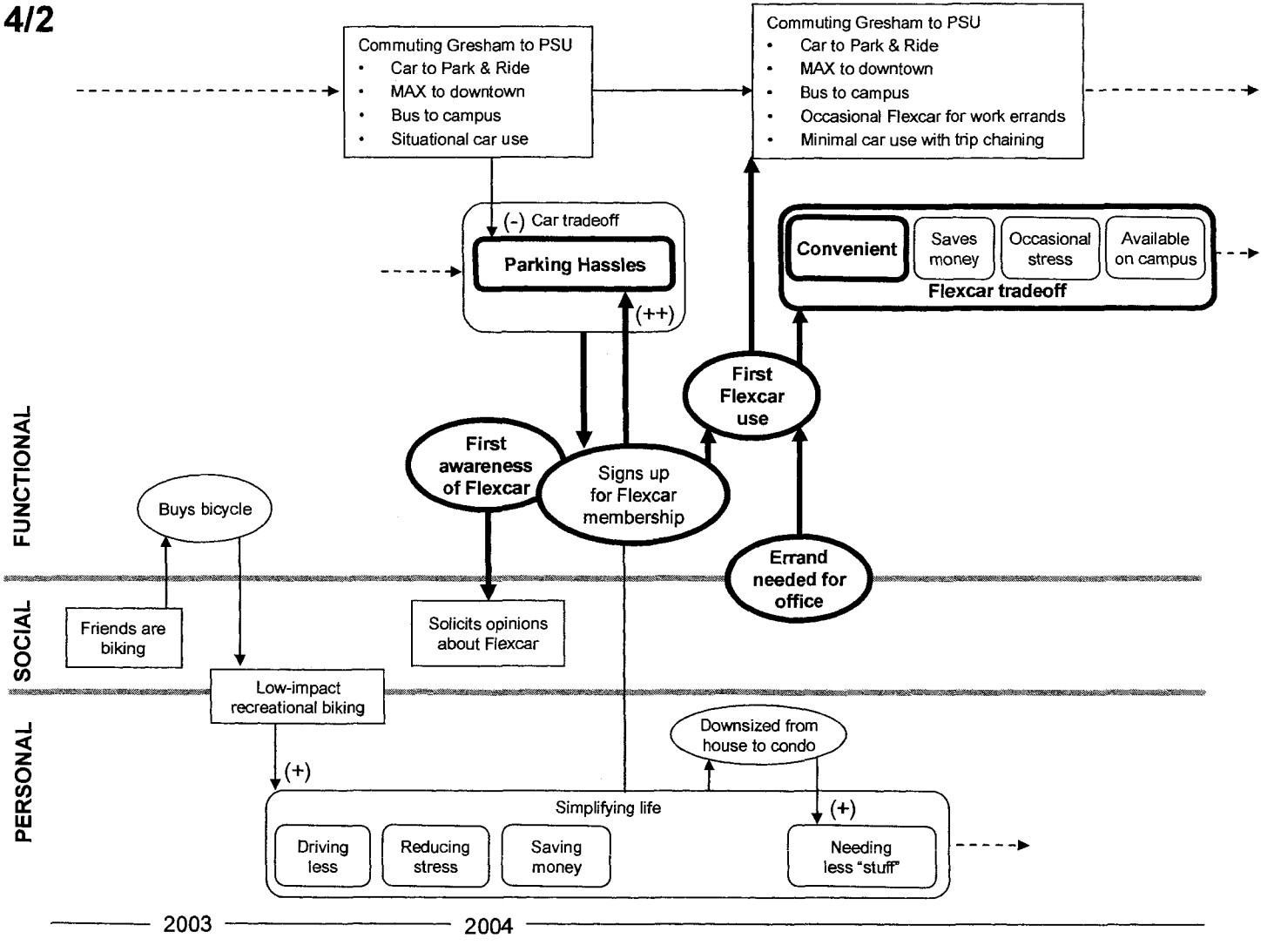

Grew up in Memphis
• 100% reliant on car
Living in Eugene
• Bikes to work
Living in Eugene
• Bus to work
Moves to Eugene
Sells car
Buys bike
Bus is slower than bike
Uses bus time to read
Safety concerns about biking
(-)
(--)
Safety concerns about biking
(+)
(-)
(++)
(+)
(-)
Time Utilization
Bus is cheap
Bus not always available
Bus tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
Memphis is transit-unfriendly
Memphis is bike-unfriendly
Hit and run biking "accident"
Hears Eugene is bike-friendly
Hit by car while biking
First bus ride
Stops biking
Getting Exercise
Stops biking
Breaks ankle snowboarding
Low-impact recreational biking
Early Adulthood
1995
1998
1999

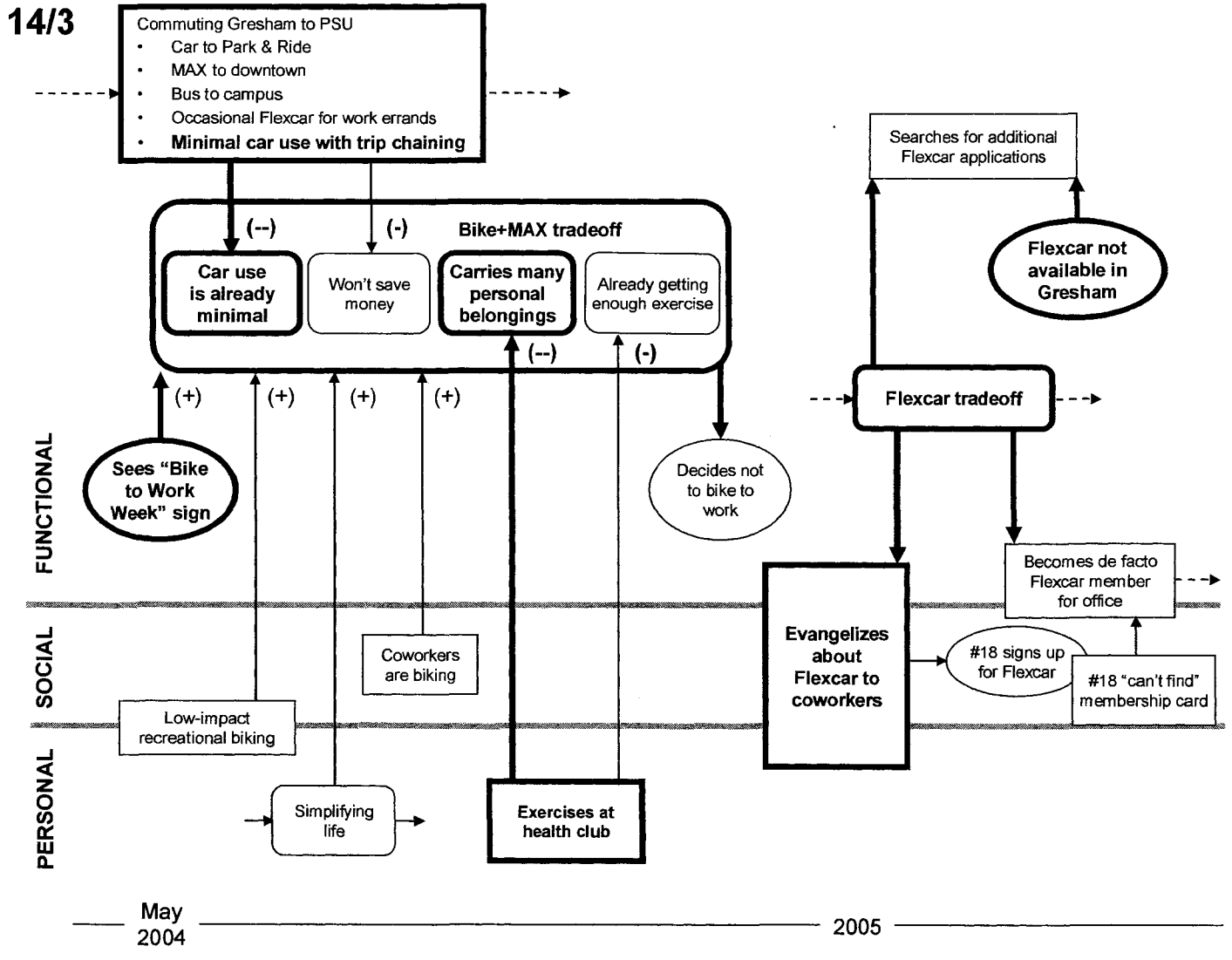
10/2


Living in San Francisco
• Ferry to work
Living in Portland (Sellwood, Forest Park)
• 100% reliant on car
Living in Portland (N. Portland; Sullivan's Gulch)
• MAX (Fareless Square, discounted tickets)
• PCC Shuttle
• Some limited biking
• Situational car use (greatly reduced)
Moves to San Francisco
Moves to Portland
Unable to find acceptable transit options
Acquires car
Cornell Rd. is too dangerous to bike
Moves to be nearer to transit options
Safety concerns about biking
(--)
(-)
(++)
Time utilization
Expensive
Lack of exercise
Car tradeoff
Visits parents in Lake Oswego
FUNCTIONAL
SOCIAL
PERSONAL
2000
2001
2004

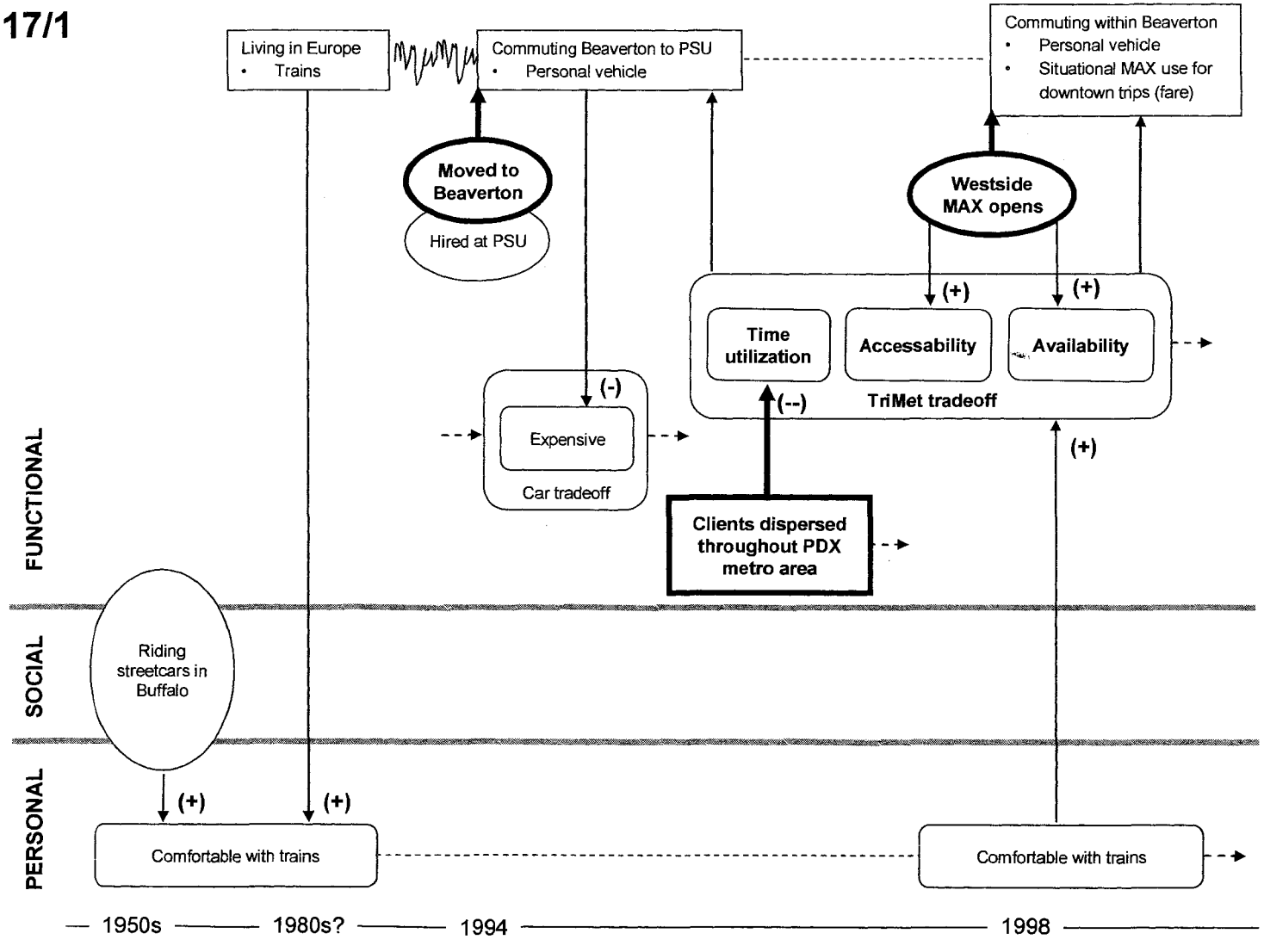

10/3
Living in Portland (commuting to PSU)
• MAX (Passport Plus)
Living in Portland (commuting to PSU)
• Bikes to work in good weather
• Rides MAX in bad weather (using discounted tickets)
• Situational car use
Purchases PP+
Discovers PP+ is not prorated for the first two missed months
Returns PP+ for refund
Hired at PSU
Signs up for campus locker
(-)
Cost effectiveness of PP+
Buyer's remorse over PP+
(--)
Discovers laundry and showers on campus
First bike ride to campus
Bikes through hard rainstorm
Realizes biking is a viable option
(+)
(+)
(+)
(++)
Showers, lockers, secure parking
Safety concerns about bikes
Weather concerns
FUNCTIONAL
SOCIAL
PERSONAL
Sees many bikes on campus
(+)
Social acceptance of biking
(++)
Sense of Achievement
Getting Exercise
(+)
(+)
(+)
(+)
(++)
(++)
Bike tradeoff
Oct 31 2005
Nov 1 2005
Nov 2 2005
Nov 3 2005
Nov 4 2005
2006

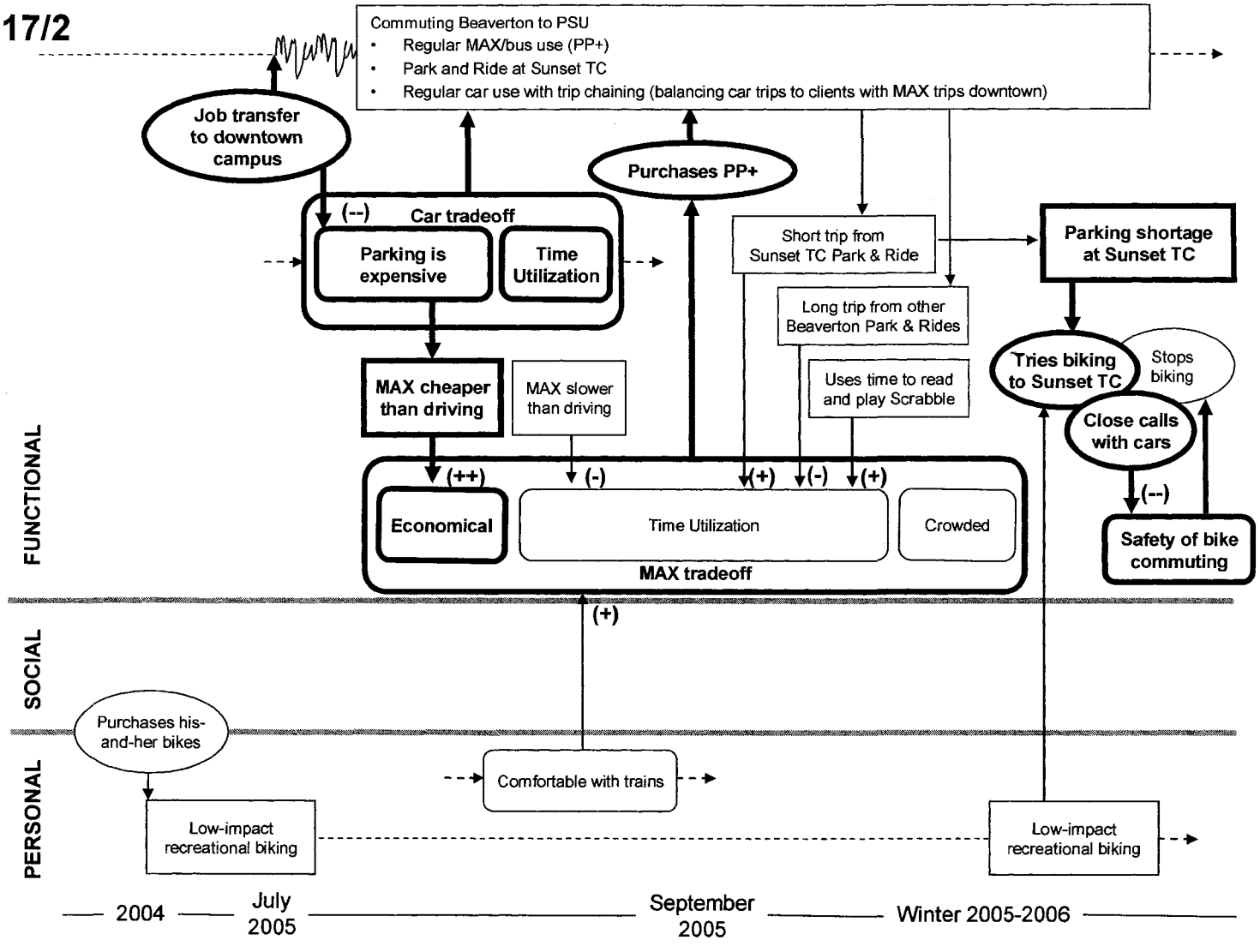

Commuting Gresham to PSU
• Exclusive car use
Commuting Gresham to PSU
• Car to Park & Ride
• MAX to downtown
• Bus to campus
• Situational car use
Hired at PSU
(-)
(++)
Parking Hassles
Traffic Congestion
Cars are expensive
Car tradeoff
Reduces Stress
Minor Security Concerns
Saves Money
MAX is slow downtown
MAX tradeoff
(+)
Purchases PP+
First awareness of PP+
Eastside MAX opens
Reads on MAX
FUNCTIONAL
SOCIAL
PERSONAL
Occasional recreational MAX use
1977
1986
October 2000


Commuting Gresham to PSU
• Car to Park & Ride
• MAX to downtown
• Bus to campus
• Situational car use
Commuting Gresham to PSU
• Car to Park & Ride
• MAX to downtown
• Bus to campus
• Occasional Flexcar for work errands
• Minimal car use with trip chaining
(-) Car tradeoff
Parking Hassles
(++)
Convenient
Saves money
Occasional stress
Available on campus
Flexcar tradeoff
First Flexcar use
First awareness of Flexcar
Signs up for Flexcar membership
Errand needed for office
FUNCTIONAL
SOCIAL
PERSONAL
Buys bicycle
Friends are biking
Solicits opinions about Flexcar
Low-impact recreational biking
Downsized from house to condo
(+)
Simplifying life
Driving less
Reducing stress
Saving money
(+)
Needing less "stuff"
2003
2004

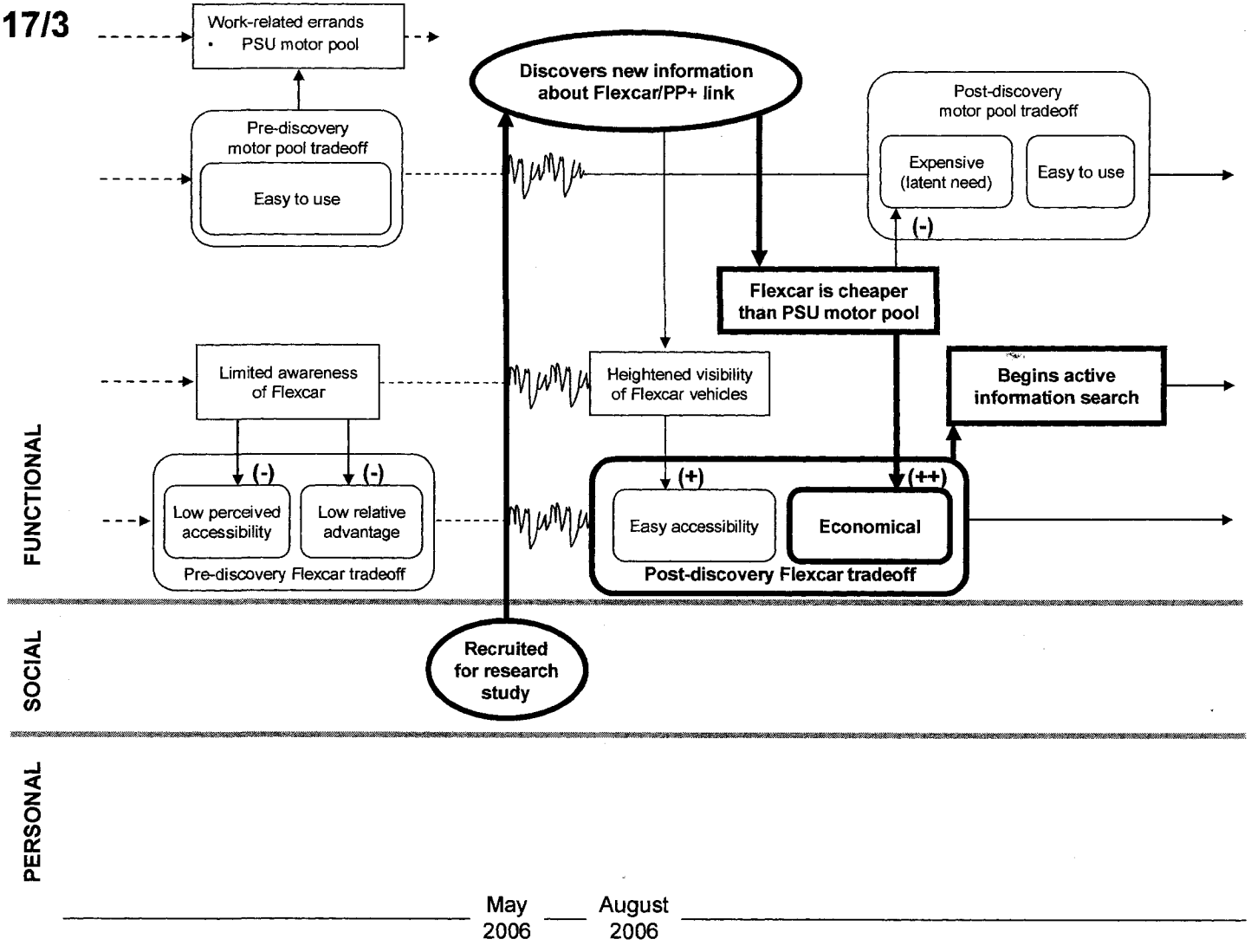

14/3
Commuting Gresham to PSU
• Car to Park & Ride
• MAX to downtown
• Bus to campus
• Occasional Flexcar for work errands
• Minimal car use with trip chaining
(--)
(-)
Bike+MAX tradeoff
Car use is already minimal
Won't save money
Carries many personal belongings
Already getting enough exercise
(--)
(-)
(+)
(+)
(+)
(+)
Searches for additional Flexcar applications
Flexcar not available in Gresham
Flexcar tradeoff
Sees "Bike to Work Week" sign
Decides not to bike to work
FUNCTIONAL
SOCIAL
PERSONAL
Becomes de facto Flexcar member for office
Evangelizes about Flexcar to coworkers
#18 signs up for Flexcar
#18 "can't find" membership card
Coworkers are biking
Low-impact recreational biking
Simplifying life
Exercises at health club
May 2004
2005

17/1


Living in Europe
• Trains
Commuting Beaverton to PSU
• Personal vehicle
Commuting within Beaverton
• Personal vehicle
• Situational MAX use for downtown trips (fare)
Moved to Beaverton
Hired at PSU
Westside MAX opens
(+)
(+)
Time utilization
Accessability
Availability
TriMet tradeoff
(-)
Expensive
Car tradeoff
(--)
(+)
Clients dispersed throughout PDX metro area
FUNCTIONAL
SOCIAL
PERSONAL
Riding streetcars in Buffalo
(+)
(+)
Comfortable with trains
Comfortable with trains
1950s
1980s?
1994
1998

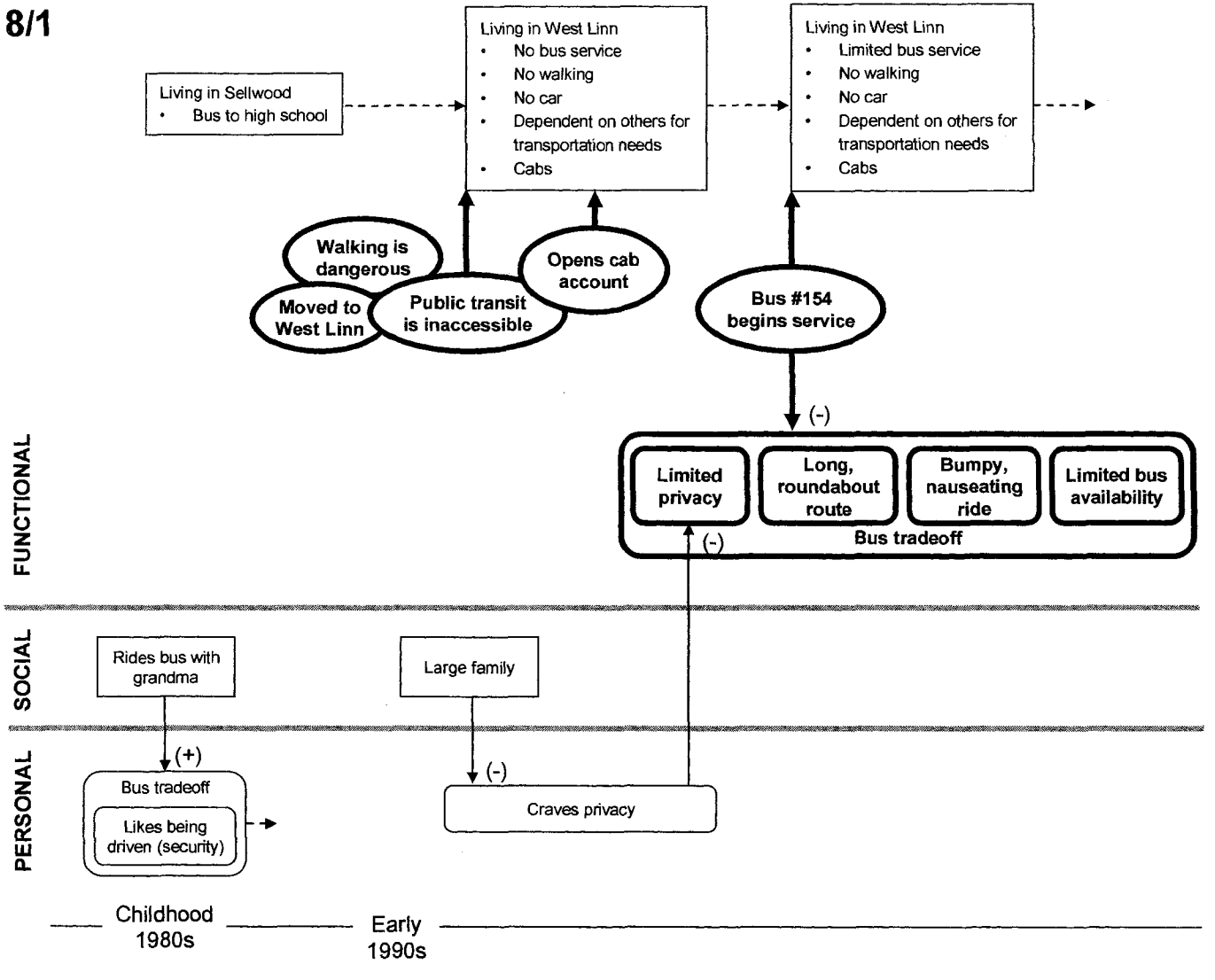

Commuting Beaverton to PSU
• Regular MAX/bus use (PP+)
• Park and Ride at Sunset TC
• Regular car use with trip chaining (balancing car trips to clients with MAX trips downtown)
Job transfer to downtown campus
Purchases PP+
(--) Car tradeoff
Parking is expensive
Time Utilization
Short trip from Sunset TC Park & Ride
Parking shortage at Sunset TC
Long trip from other Beaverton Park & Rides
Tries biking to Sunset TC
Stops biking
Uses time to read and play Scrabble
Close calls with cars
MAX cheaper than driving
MAX slower than driving
(++)
(-)
(+)
(-)
(+)
Economical
Time Utilization
Crowded
MAX tradeoff
(--)
Safety of bike commuting
FUNCTIONAL
(+)
SOCIAL
Purchases his-and-her bikes
Comfortable with trains
PERSONAL
Low-impact recreational biking
Low-impact recreational biking
2004
July 2005
September 2005
Winter 2005-2006

(416)


Work-related errands
• PSU motor pool
Pre-discovery motor pool tradeoff
Easy to use
Discovers new information about Flexcar/PP+ link
Post-discovery motor pool tradeoff
Expensive (latent need)
Easy to use
(-)
Flexcar is cheaper than PSU motor pool
Limited awareness of Flexcar
Heightened visibility of Flexcar vehicles
Begins active information search
(-)
(-)
Low perceived accessibility
Low relative advantage
Pre-discovery Flexcar tradeoff
(+)
(++)
Easy accessibility
Economical
Post-discovery Flexcar tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
Recruited for research study
May 2006
August 2006

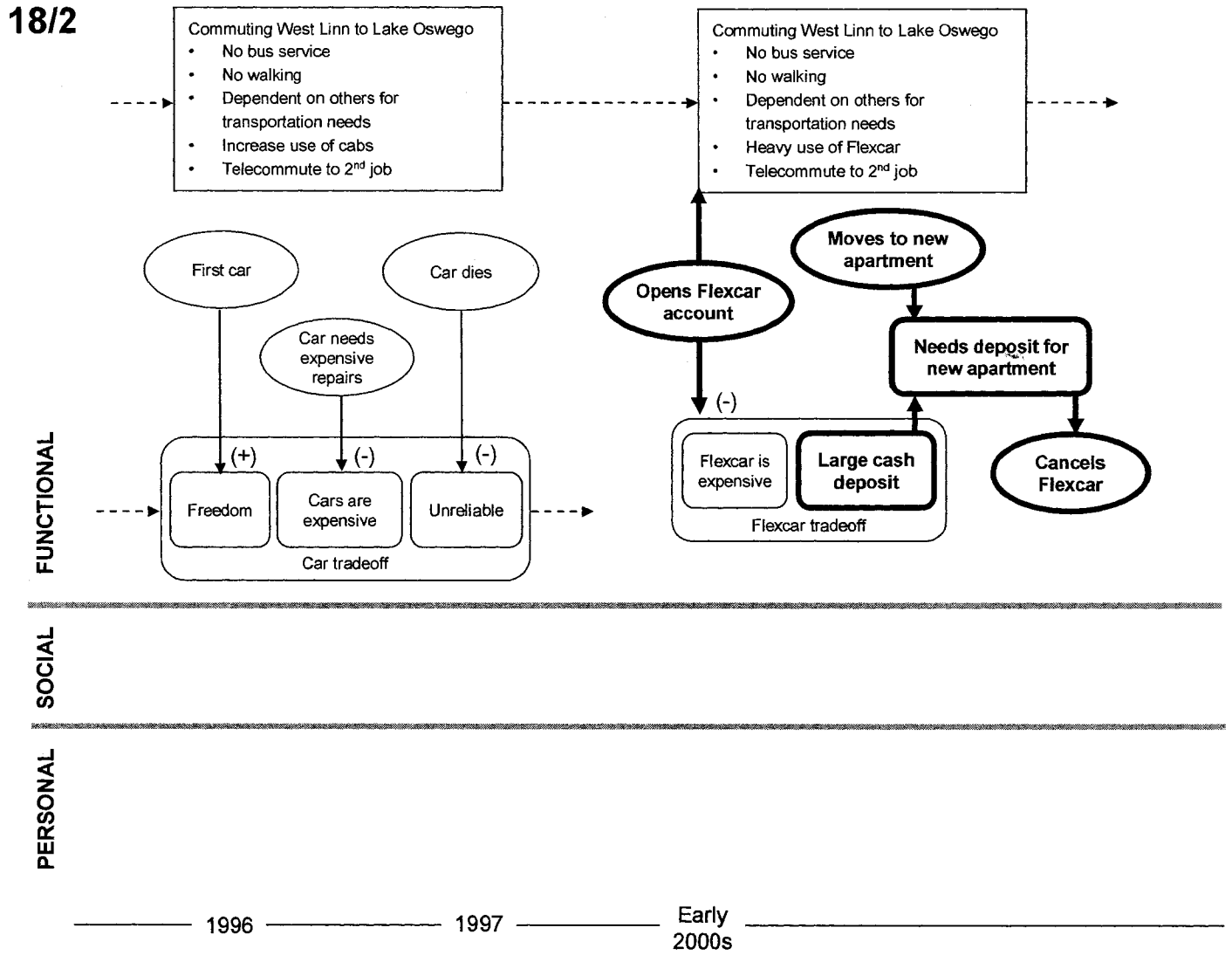
(417)

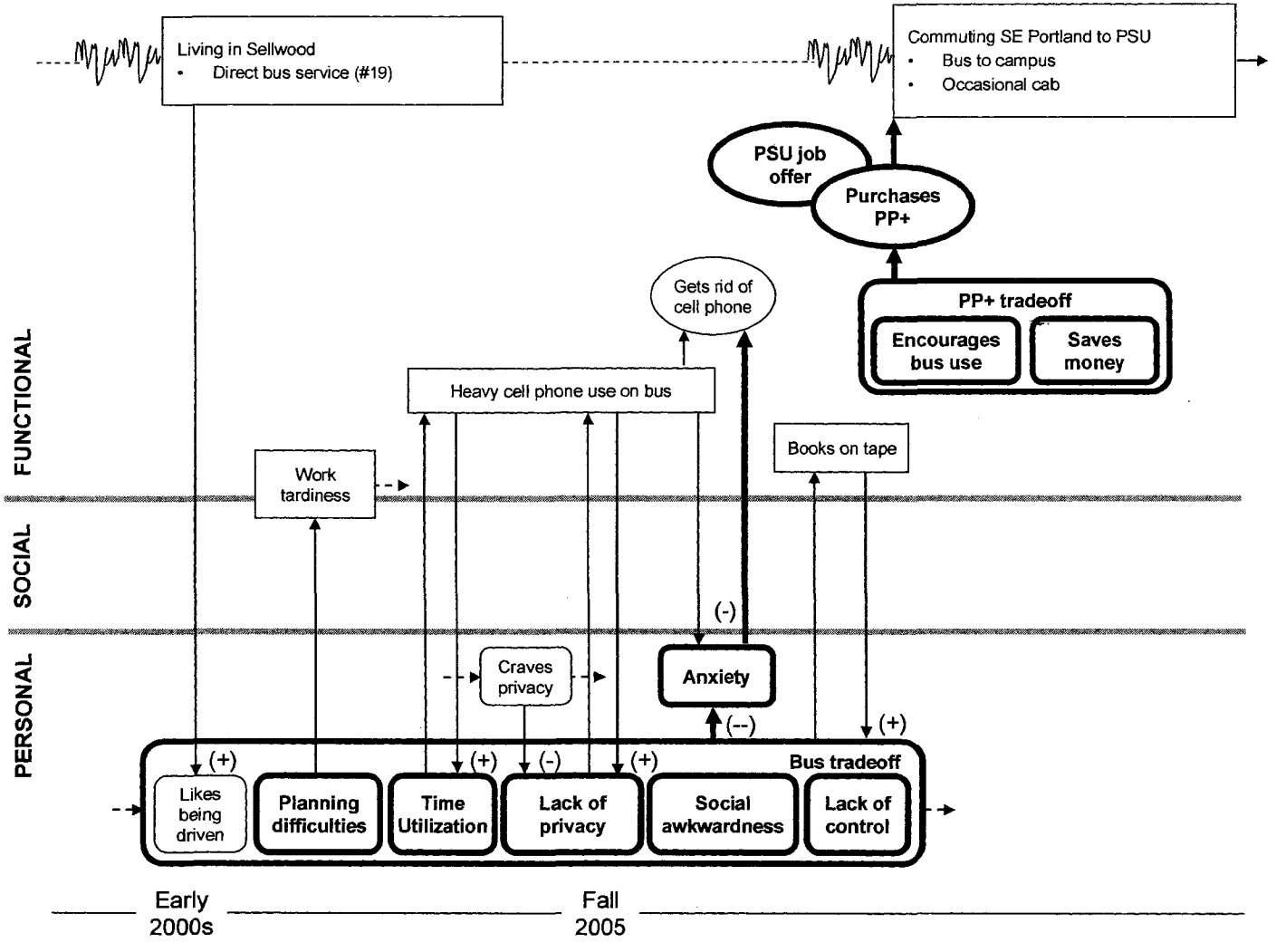
18/1


Living in Sellwood
• Bus to high school
Living in West Linn
• No bus service
• No walking
• No car
• Dependent on others for transportation needs
• Cabs
Living in West Linn
• Limited bus service
• No walking
• No car
• Dependent on others for transportation needs
• Cabs
Walking is dangerous
Moved to West Linn
Public transit is inaccessible
Opens cab account
Bus #154 begins service
(-)
Limited privacy
Long, roundabout route
Bumpy, nauseating ride
Limited bus availability
Bus tradeoff
(-)
FUNCTIONAL
SOCIAL
PERSONAL
Rides bus with grandma
Large family
(+)
(-)
Bus tradeoff
Likes being driven (security)
Craves privacy
Childhood 1980s
Early 1990s

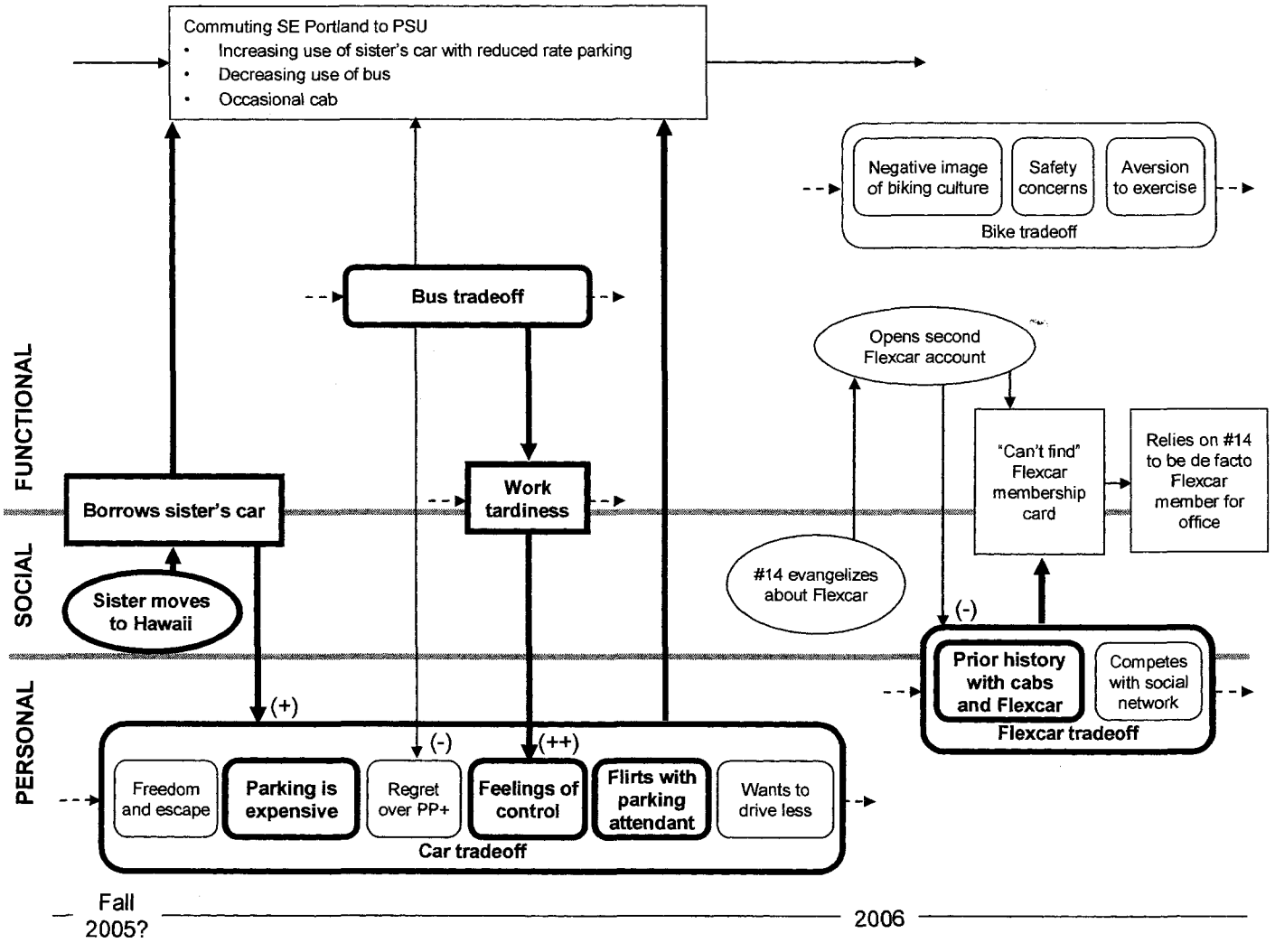
(418)

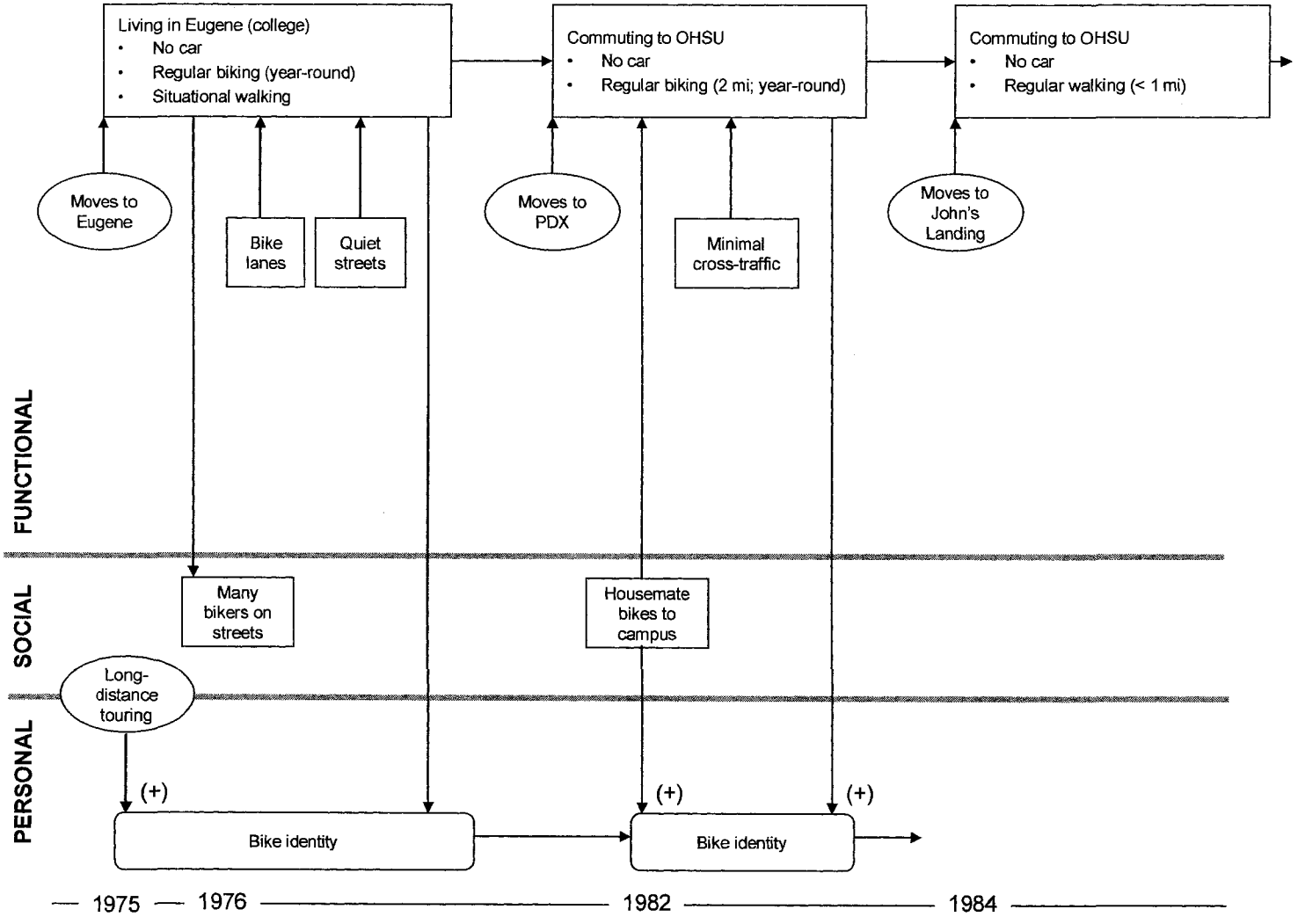
18/2

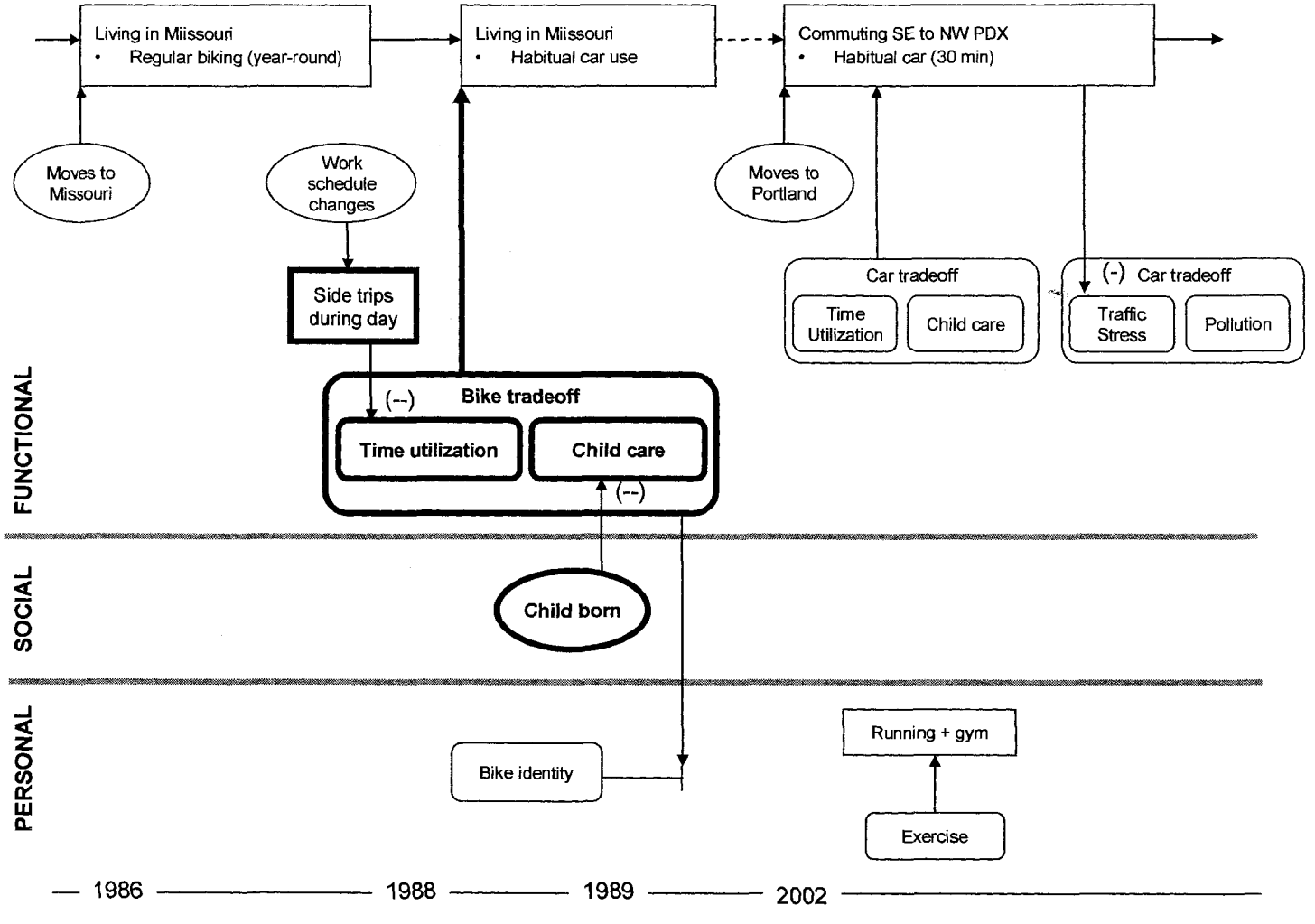

Commuting West Linn to Lake Oswego
• No bus service
• No walking
• Dependent on others for transportation needs
• Increase use of cabs
• Telecommute to 2nd job
Commuting West Linn to Lake Oswego
• No bus service
• No walking
• Dependent on others for transportation needs
• Heavy use of Flexcar
• Telecommute to 2nd job
First car
Car dies
Car needs expensive repairs
Opens Flexcar account
Moves to new apartment
Needs deposit for new apartment
(-)
(+)
(-)
(-)
Freedom
Cars are expensive
Unreliable
Car tradeoff
Flexcar is expensive
Large cash deposit
Cancels Flexcar
Flexcar tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
1996
1997
Early 2000s

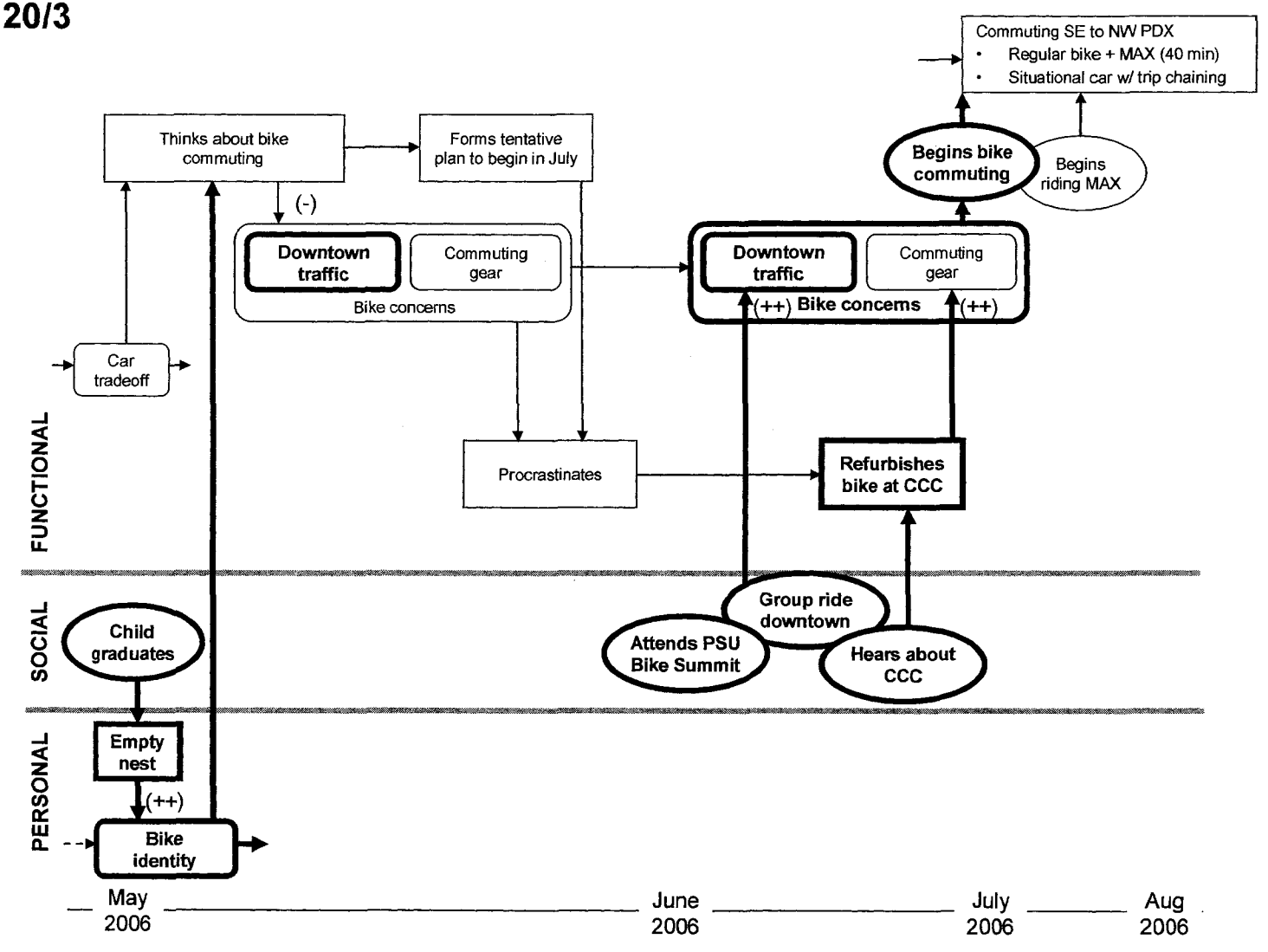

Living in Sellwood
• Direct bus service (#19)
Commuting SE Portland to PSU
• Bus to campus
• Occasional cab
PSU job offer
Purchases PP+
PP+ tradeoff
Encourages bus use
Saves money
Gets rid of cell phone
Heavy cell phone use on bus
Books on tape
Work tardiness
FUNCTIONAL
SOCIAL
PERSONAL
(-)
Craves privacy
Anxiety
(--)
(+)
(+)
(+)
(-)
(+)
(+)
Bus tradeoff
Likes being driven
Planning difficulties
Time Utilization
Lack of privacy
Social awkwardness
Lack of control
Early 2000s
Fall 2005

(420)


Commuting SE Portland to PSU
• Increasing use of sister's car with reduced rate parking
• Decreasing use of bus
• Occasional cab
Negative image of biking culture
Safety concerns
Aversion to exercise
Bike tradeoff
Bus tradeoff
Opens second Flexcar account
FUNCTIONAL
SOCIAL
PERSONAL
Borrows sister's car
Work tardiness
"Can't find" Flexcar membership card
Relies on #14 to be de facto Flexcar member for office
Sister moves to Hawaii
#14 evangelizes about Flexcar
(-)
Prior history with cabs and Flexcar
Competes with social network
Flexcar tradeoff
(+)
(-)
(++)
Freedom and escape
Parking is expensive
Regret over PP+
Feelings of control
Flirts with parking attendant
Wants to drive less
Car tradeoff
Fall 2005?
2006

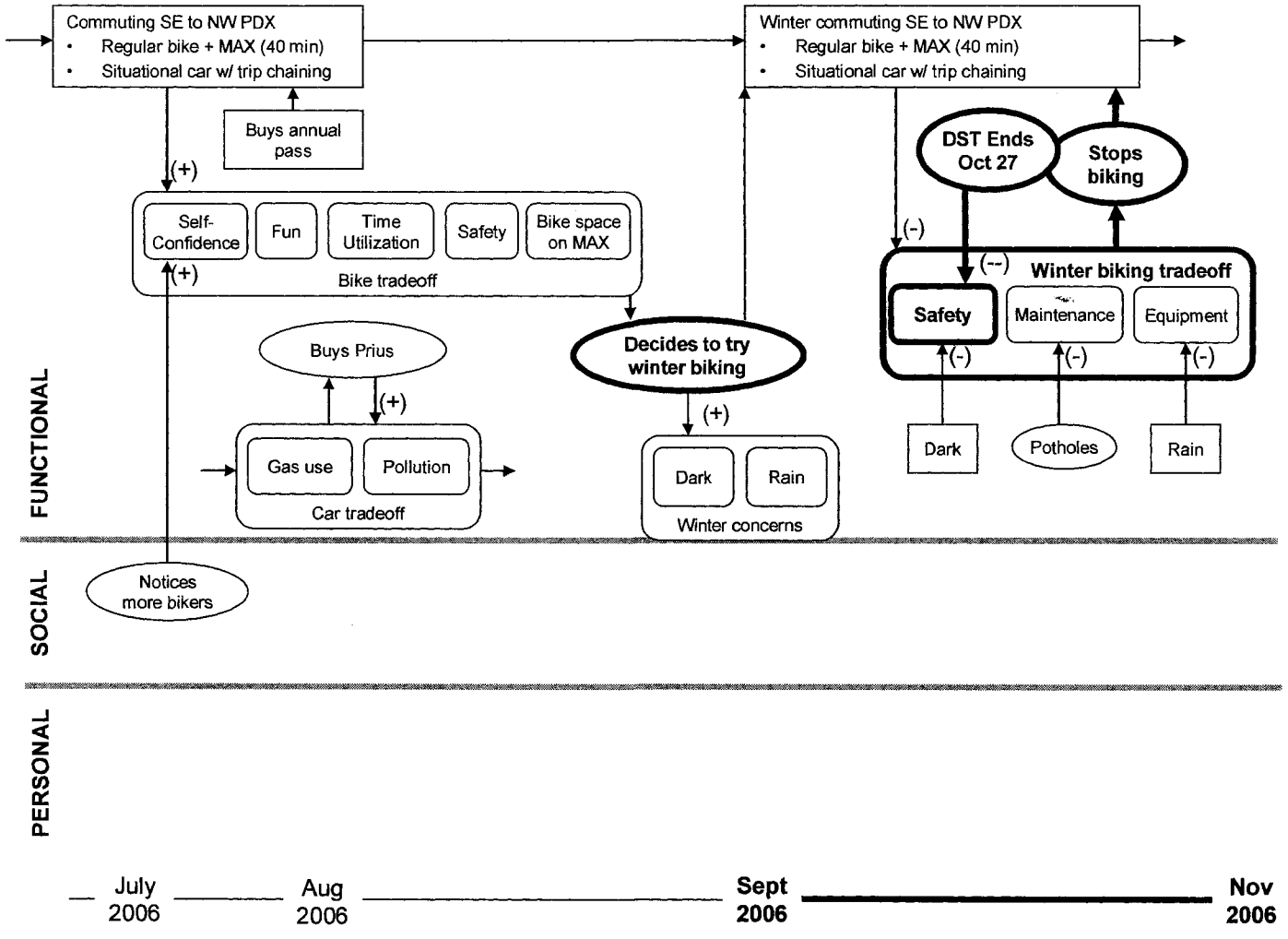

Living in Eugene (college)
• No car
• Regular biking (year-round)
• Situational walking
Commuting to OHSU
• No car
• Regular biking (2 mi; year-round)
Commuting to OHSU
• No car
• Regular walking (< 1 mi)
Moves to Eugene
Bike lanes
Quiet streets
Moves to PDX
Minimal cross-traffic
Moves to John's Landing
FUNCTIONAL
SOCIAL
PERSONAL
Many bikers on streets
Housemate bikes to campus
Long-distance touring
(+)
(+)
(+)
Bike identity
Bike identity
1975
1976
1982
1984


Living in Miissouri
• Regular biking (year-round)
Living in Miissouri
• Habitual car use
Commuting SE to NW PDX
• Habitual car (30 min)
Moves to Missouri
Work schedule changes
Moves to Portland
Side trips during day
Car tradeoff
Time Utilization
Child care
(-) Car tradeoff
Traffic Stress
Pollution
(--) Bike tradeoff
Time utilization
Child care
(--)
FUNCTIONAL
SOCIAL
Child born
PERSONAL
Bike identity
Running + gym
Exercise
1986
1988
1989
2002

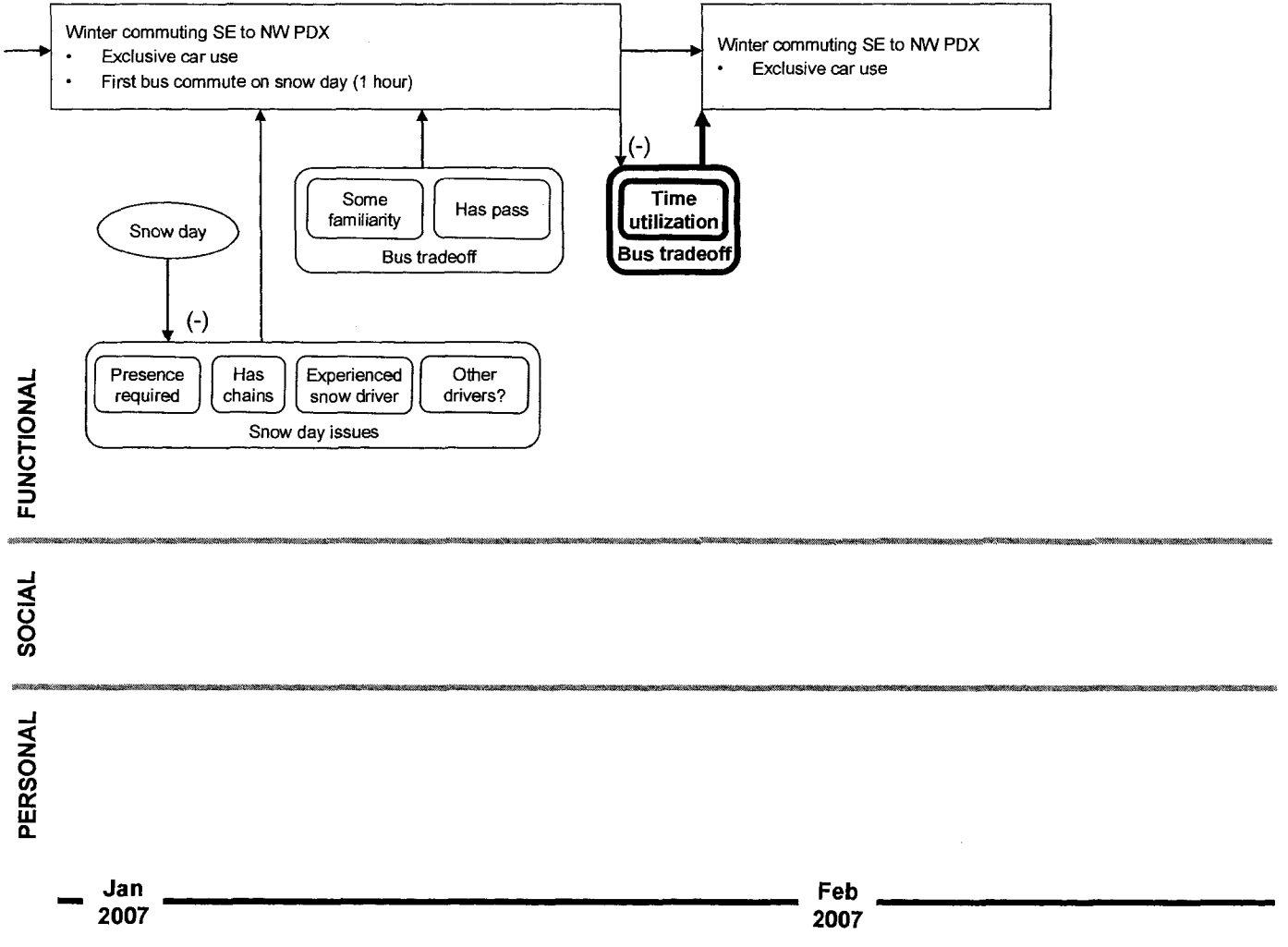

Commuting SE to NW PDX
• Regular bike + MAX (40 min)
• Situational car w/ trip chaining
Thinks about bike commuting
Forms tentative plan to begin in July
Begins bike commuting
Begins riding MAX
(-)
Downtown traffic
Commuting gear
Bike concerns
Downtown traffic
Commuting gear
(++) Bike concerns (++)
Car tradeoff
Procrastinates
Refurbishes bike at CCC
FUNCTIONAL
SOCIAL
PERSONAL
Child graduates
Group ride downtown
Attends PSU Bike Summit
Hears about CCC
Empty nest
(++)
Bike identity
May 2006
June 2006
July 2006
Aug 2006

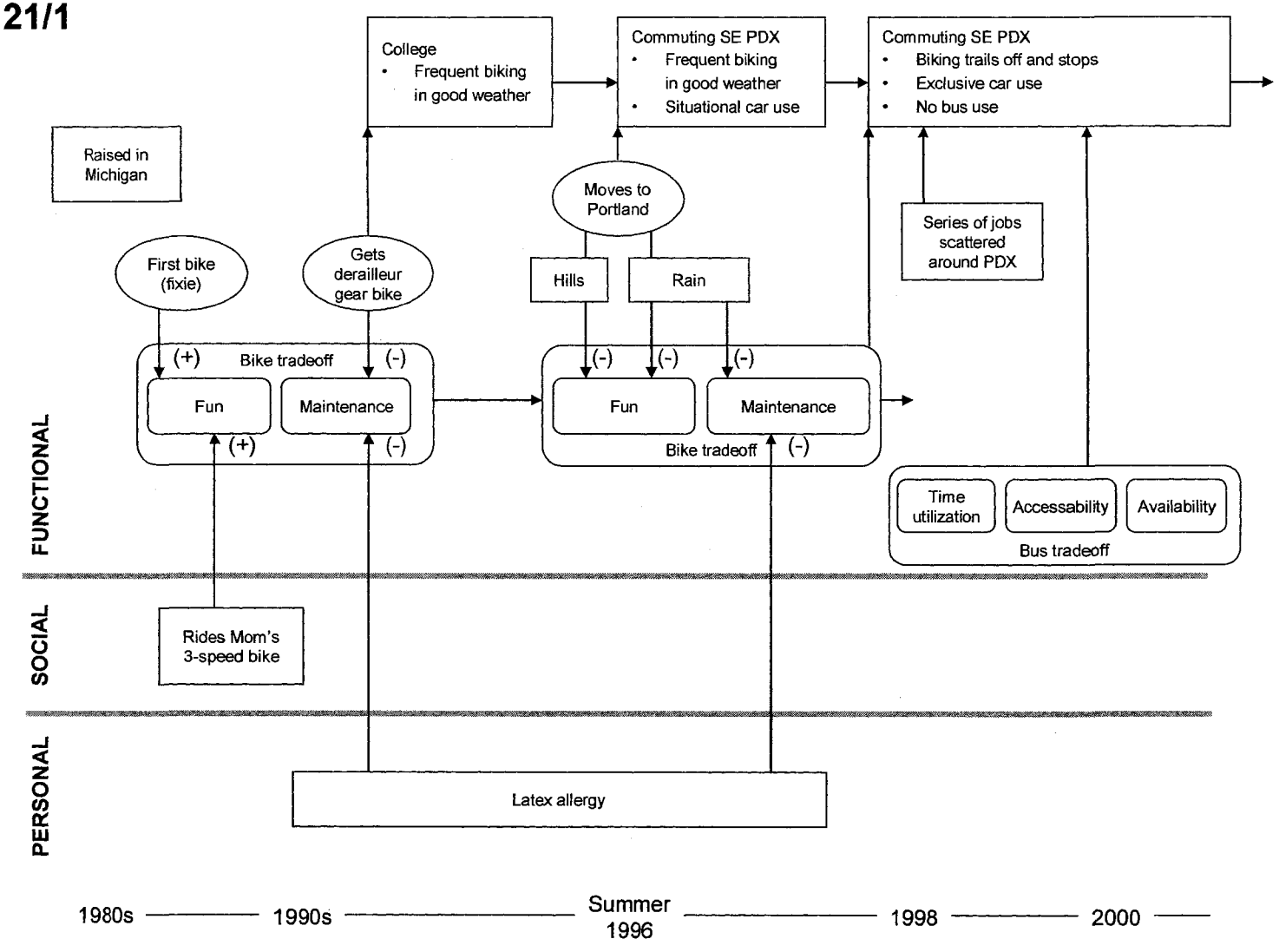
(424)

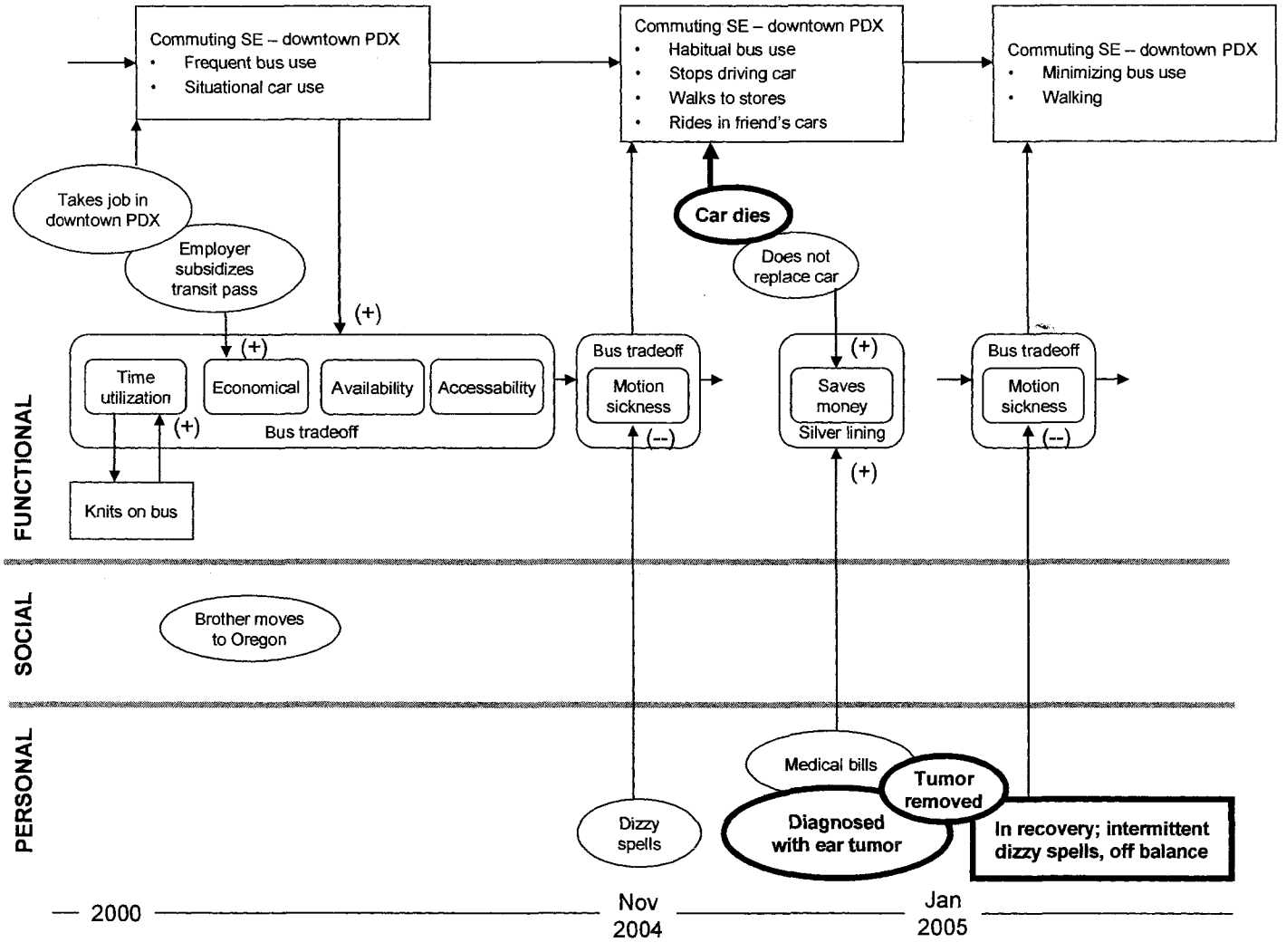
20/4


Commuting SE to NW PDX
• Regular bike + MAX (40 min)
• Situational car w/ trip chaining
Buys annual pass
(+)
Self-Confidence
Fun
Time Utilization
Safety
Bike space on MAX
(+)
Bike tradeoff
Buys Prius
(+)
Gas use
Pollution
Car tradeoff
Decides to try winter biking
(+)
Dark
Rain
Winter concerns
Winter commuting SE to NW PDX
• Regular bike + MAX (40 min)
• Situational car w/ trip chaining
DST Ends Oct 27
Stops biking
(-)
(--)
Winter biking tradeoff
Safety
Maintenance
Equipment
(-)
(-)
(-)
Dark
Potholes
Rain
FUNCTIONAL
SOCIAL
PERSONAL
Notices more bikers
July 2006
Aug 2006
Sept 2006
Nov 2006

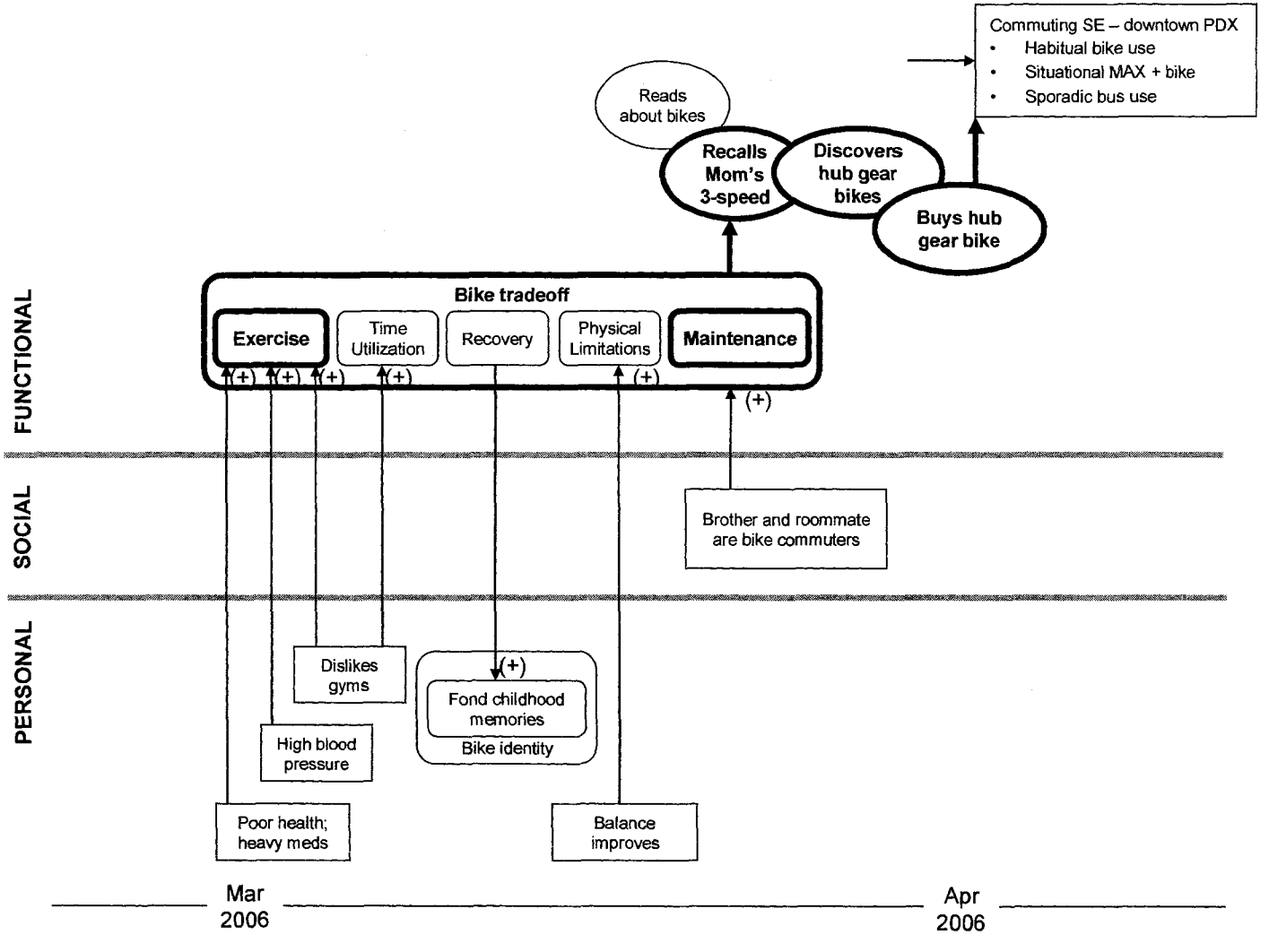
(425)


Winter commuting SE to NW PDX
• Exclusive car use
• First bus commute on snow day (1 hour)
Winter commuting SE to NW PDX
• Exclusive car use
(-)
Some familiarity
Has pass
Bus tradeoff
Time utilization
Bus tradeoff
Snow day
(-)
Presence required
Has chains
Experienced snow driver
Other drivers?
Snow day issues
FUNCTIONAL
SOCIAL
PERSONAL
Jan 2007
Feb 2007

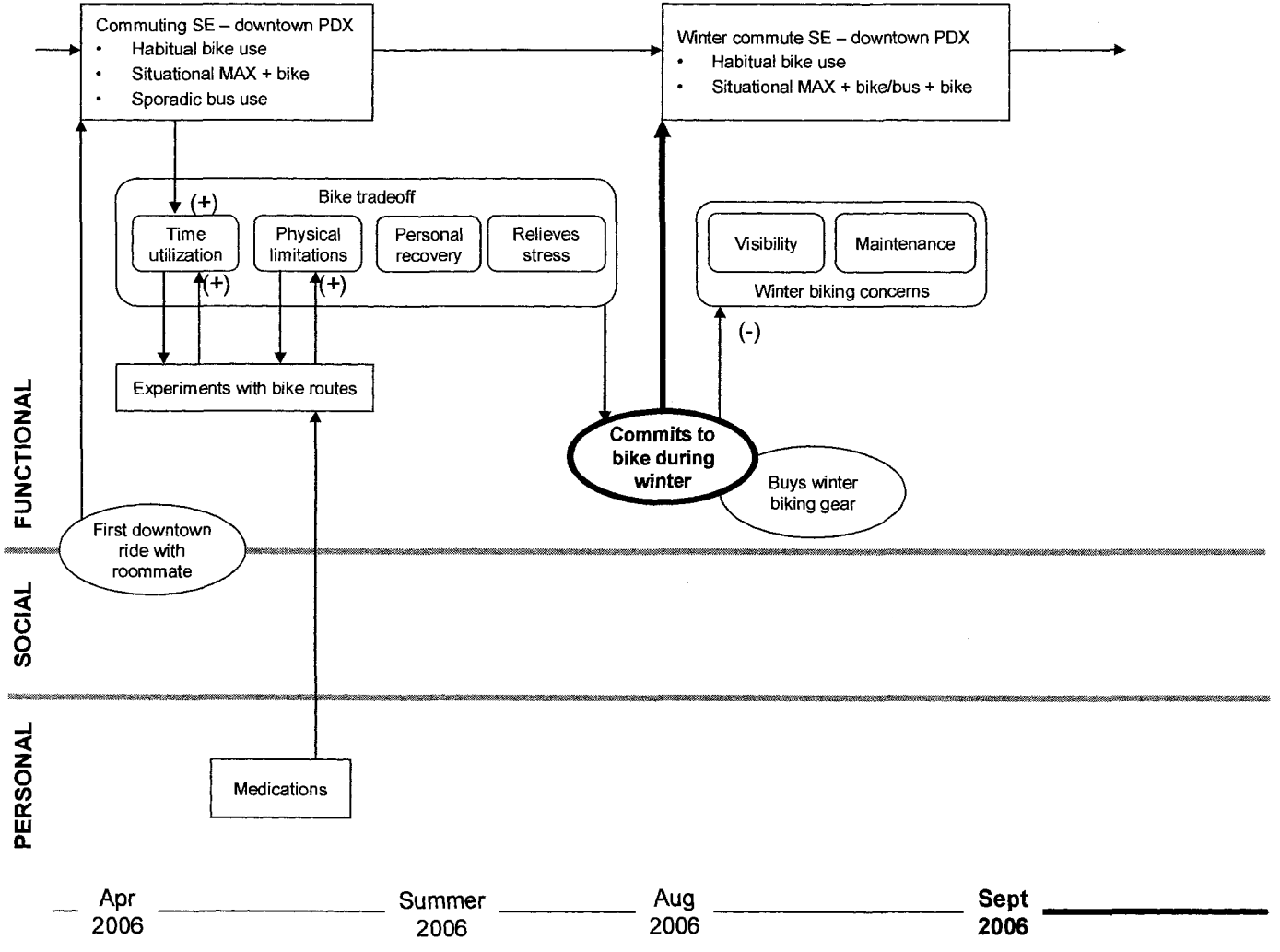

College
• Frequent biking in good weather
Commuting SE PDX
• Frequent biking in good weather
• Situational car use
Commuting SE PDX
• Biking trails off and stops
• Exclusive car use
• No bus use
Raised in Michigan
Moves to Portland
Series of jobs scattered around PDX
First bike (fixie)
Gets derailleur gear bike
Hills
Rain
(+)
Bike tradeoff
(-)
Fun
Maintenance
(+)
(-)
(-)
(-)
(-)
Fun
Maintenance
Bike tradeoff
(-)
Time utilization
Accessability
Availability
Bus tradeoff
FUNCTIONAL
SOCIAL
Rides Mom's 3-speed bike
PERSONAL
Latex allergy
1980s
1990s
Summer 1996
1998
2000

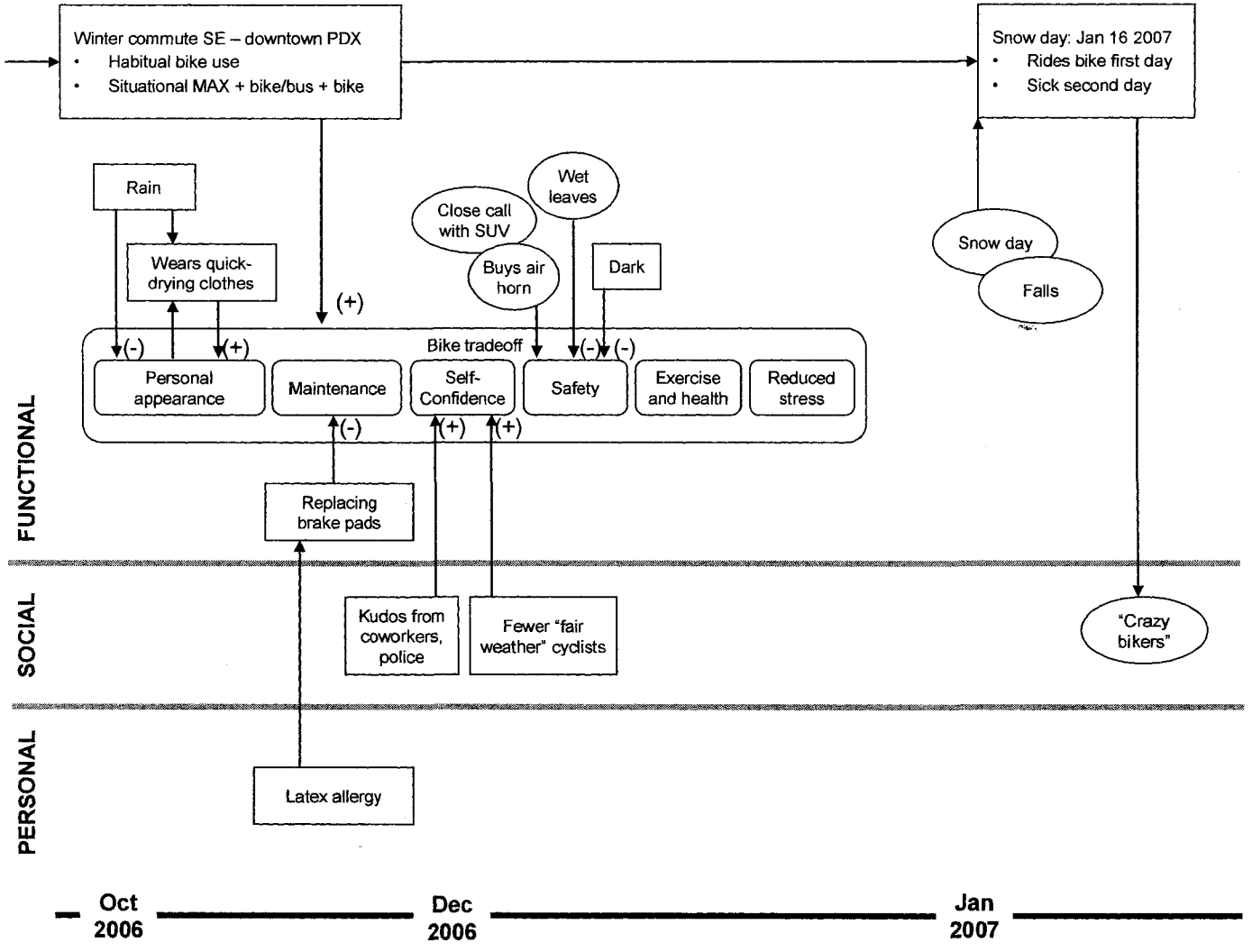

Commuting SE – downtown PDX
• Frequent bus use
• Situational car use
Commuting SE – downtown PDX
• Habitual bus use
• Stops driving car
• Walks to stores
• Rides in friend's cars
Commuting SE – downtown PDX
• Minimizing bus use
• Walking
Takes job in downtown PDX
Employer subsidizes transit pass
Car dies
Does not replace car
(+)
(+)
Time utilization
Economical
Availability
Accessability
Bus tradeoff
(+)
Knits on bus
Bus tradeoff
Motion sickness
(--)
(+)
Saves money
Silver lining
(+)
Bus tradeoff
Motion sickness
(--)
FUNCTIONAL
SOCIAL
Brother moves to Oregon
PERSONAL
Medical bills
Tumor removed
Diagnosed with ear tumor
Dizzy spells
In recovery; intermittent dizzy spells, off balance
2000
Nov 2004
Jan 2005

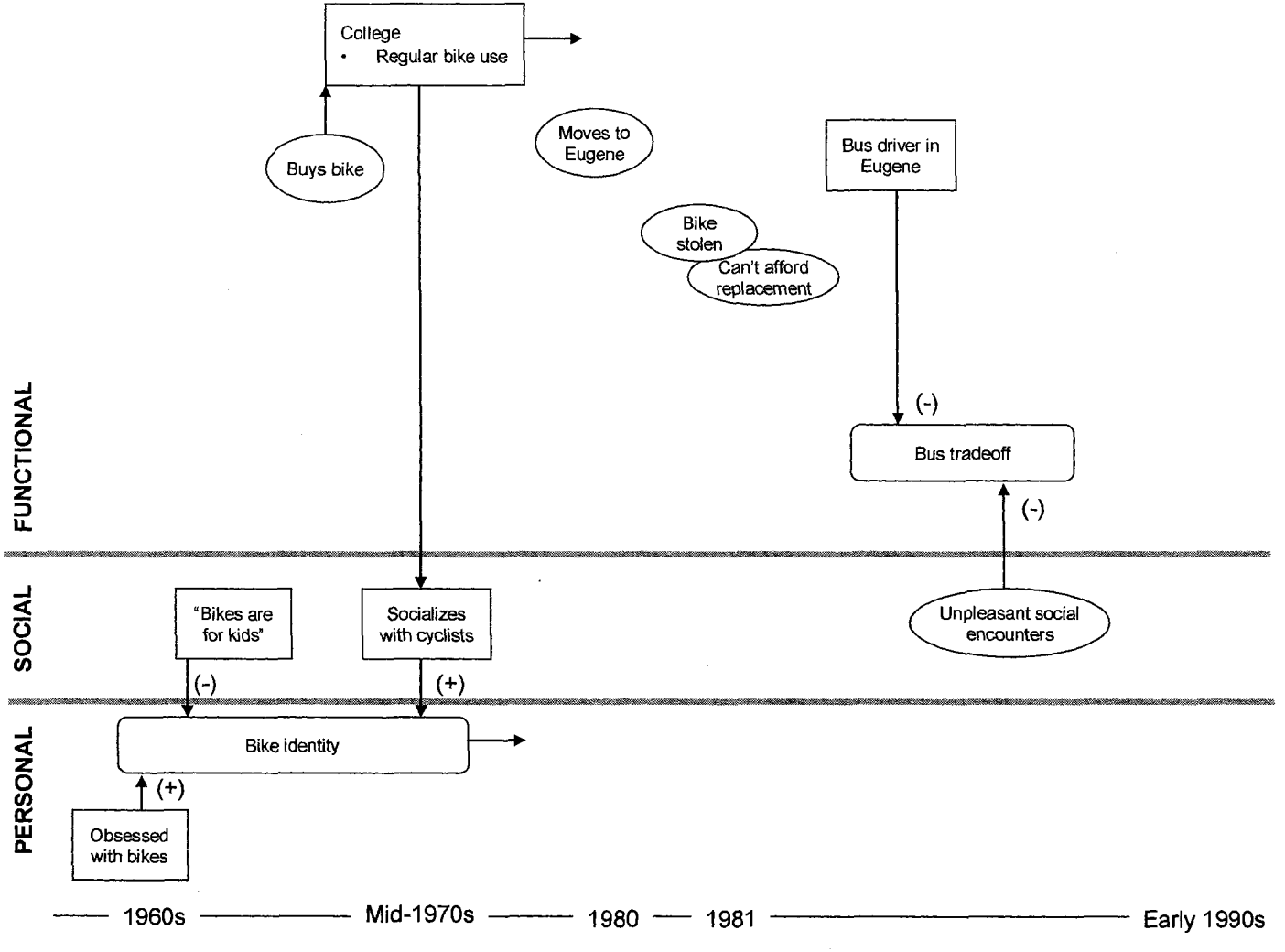
(428)


Commuting SE – downtown PDX
• Habitual bike use
• Situational MAX + bike
• Sporadic bus use
Reads about bikes
Recalls Mom's 3-speed
Discovers hub gear bikes
Buys hub gear bike
Bike tradeoff
Exercise
Time Utilization
Recovery
Physical Limitations
Maintenance
(+)
FUNCTIONAL
SOCIAL
PERSONAL
Brother and roommate are bike commuters
Dislikes gyms
Fond childhood memories
Bike identity
High blood pressure
Poor health; heavy meds
Balance improves
Mar 2006
Apr 2006

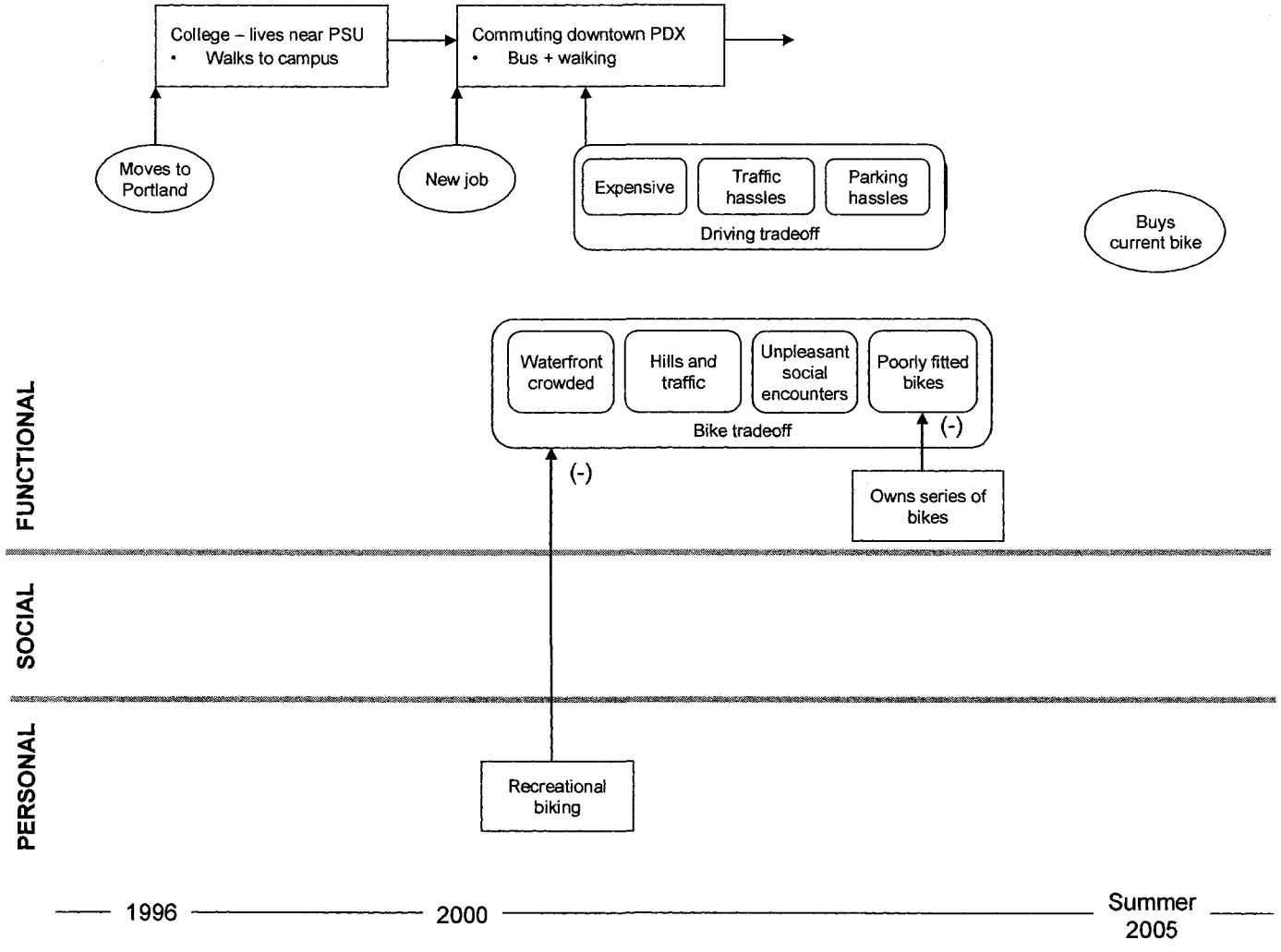
(429)

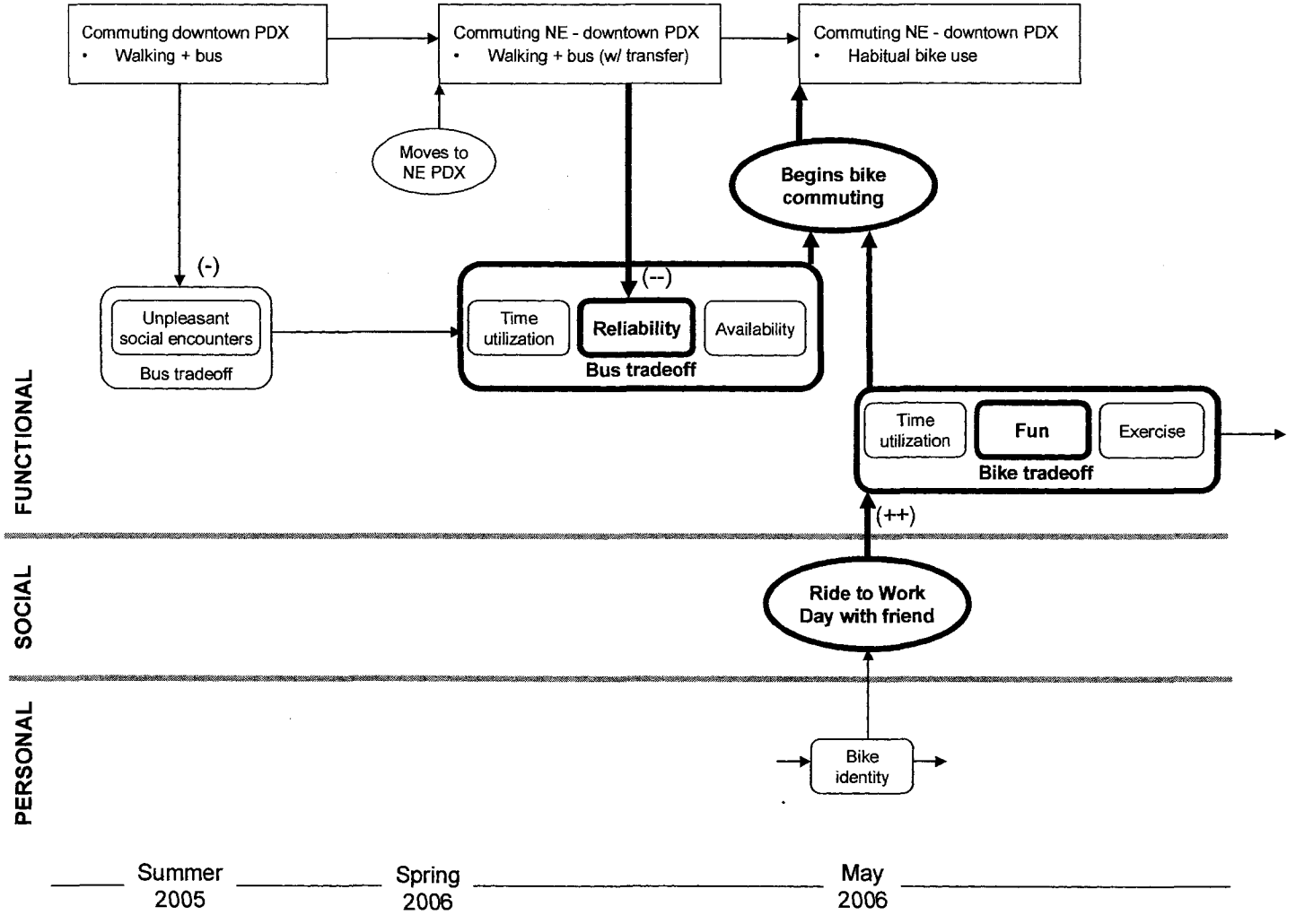

Commuting SE – downtown PDX
• Habitual bike use
• Situational MAX + bike
• Sporadic bus use
Winter commute SE – downtown PDX
• Habitual bike use
• Situational MAX + bike/bus + bike
Bike tradeoff
(+)
Time utilization
Physical limitations
Personal recovery
Relieves stress
(+)
(+)
Visibility
Maintenance
Winter biking concerns
(-)
Experiments with bike routes
Commits to bike during winter
Buys winter biking gear
First downtown ride with roommate
Medications
FUNCTIONAL
SOCIAL
PERSONAL
Apr 2006
Summer 2006
Aug 2006
Sept 2006


Winter commute SE – downtown PDX
• Habitual bike use
• Situational MAX + bike/bus + bike
Snow day: Jan 16 2007
• Rides bike first day
• Sick second day
Rain
Wears quick-drying clothes
Close call with SUV
Wet leaves
Buys air horn
Dark
Snow day
Falls
(+)
(-)
(+)
Bike tradeoff
(-)
(-)
Personal appearance
Maintenance
Self-Confidence
Safety
Exercise and health
Reduced stress
(-)
(+)
(+)
Replacing brake pads
Kudos from coworkers, police
Fewer "fair weather" cyclists
"Crazy bikers"
Latex allergy
FUNCTIONAL
SOCIAL
PERSONAL
Oct 2006
Dec 2006
Jan 2007

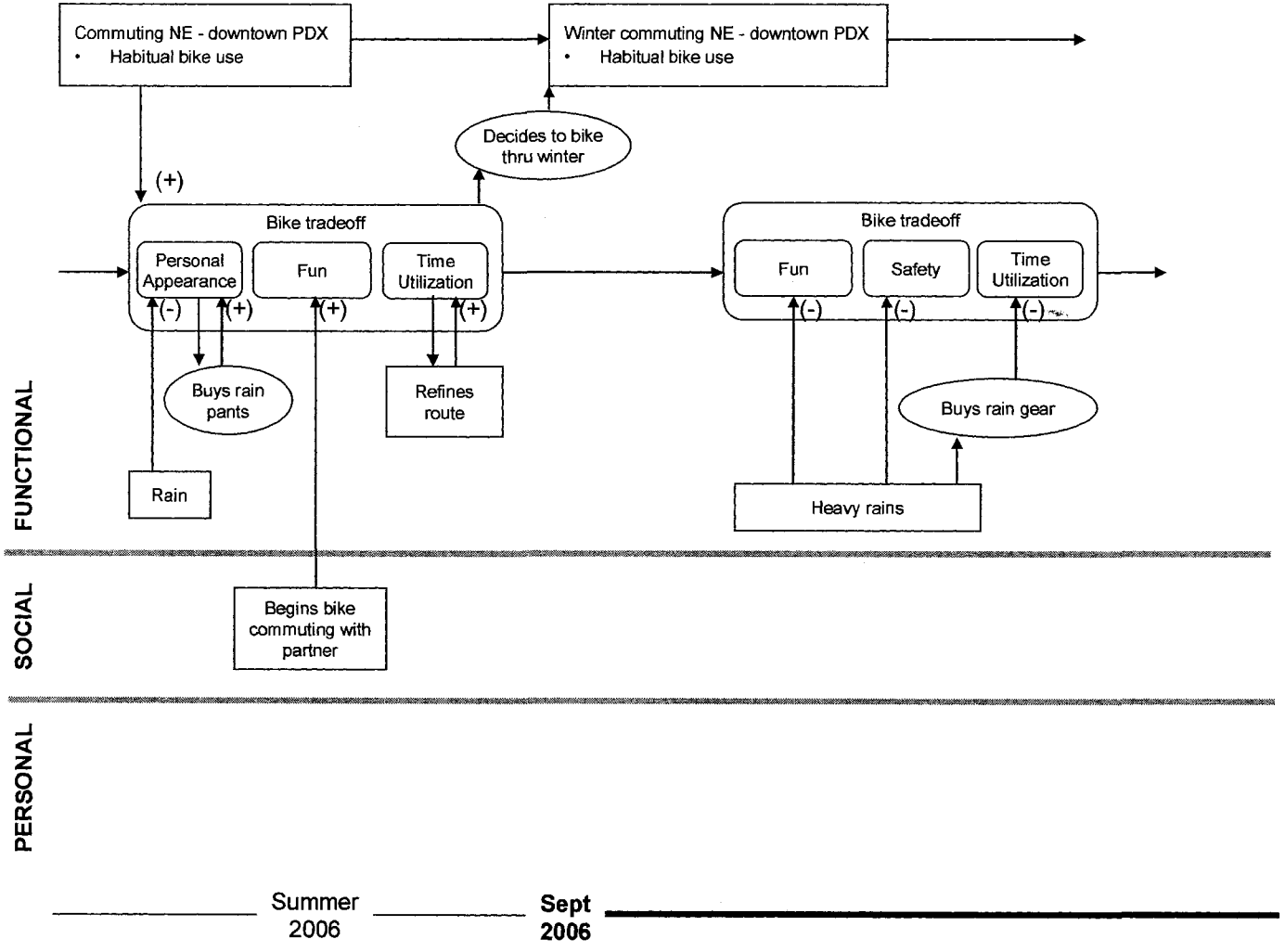

College
• Regular bike use
Buys bike
Moves to Eugene
Bike stolen
Can't afford replacement
Bus driver in Eugene
(-)
Bus tradeoff
(-)
FUNCTIONAL
SOCIAL
PERSONAL
"Bikes are for kids"
Socializes with cyclists
Unpleasant social encounters
(-)
(+)
Bike identity
(+)
Obsessed with bikes
1960s
Mid-1970s
1980
1981
Early 1990s

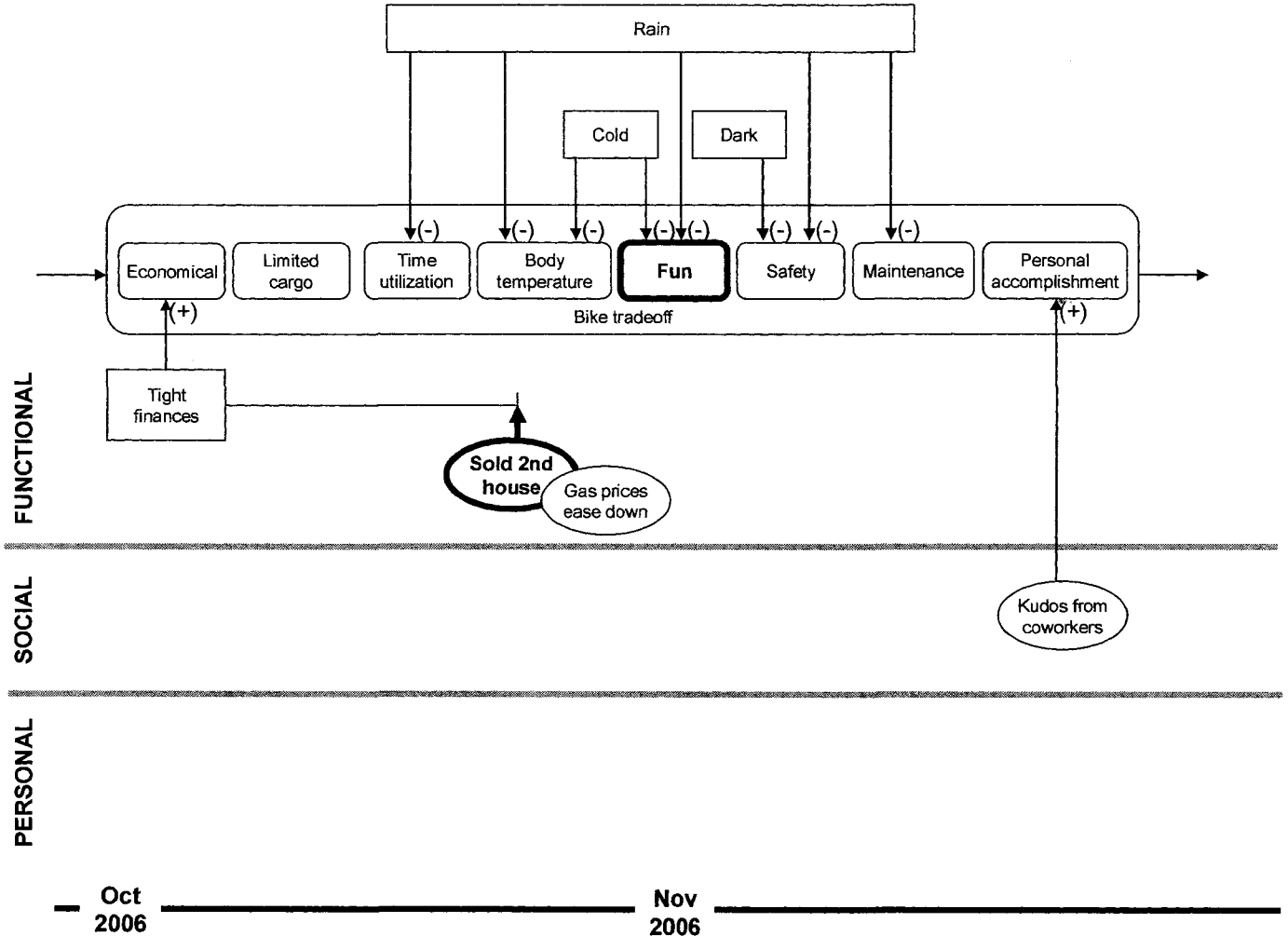
22/2

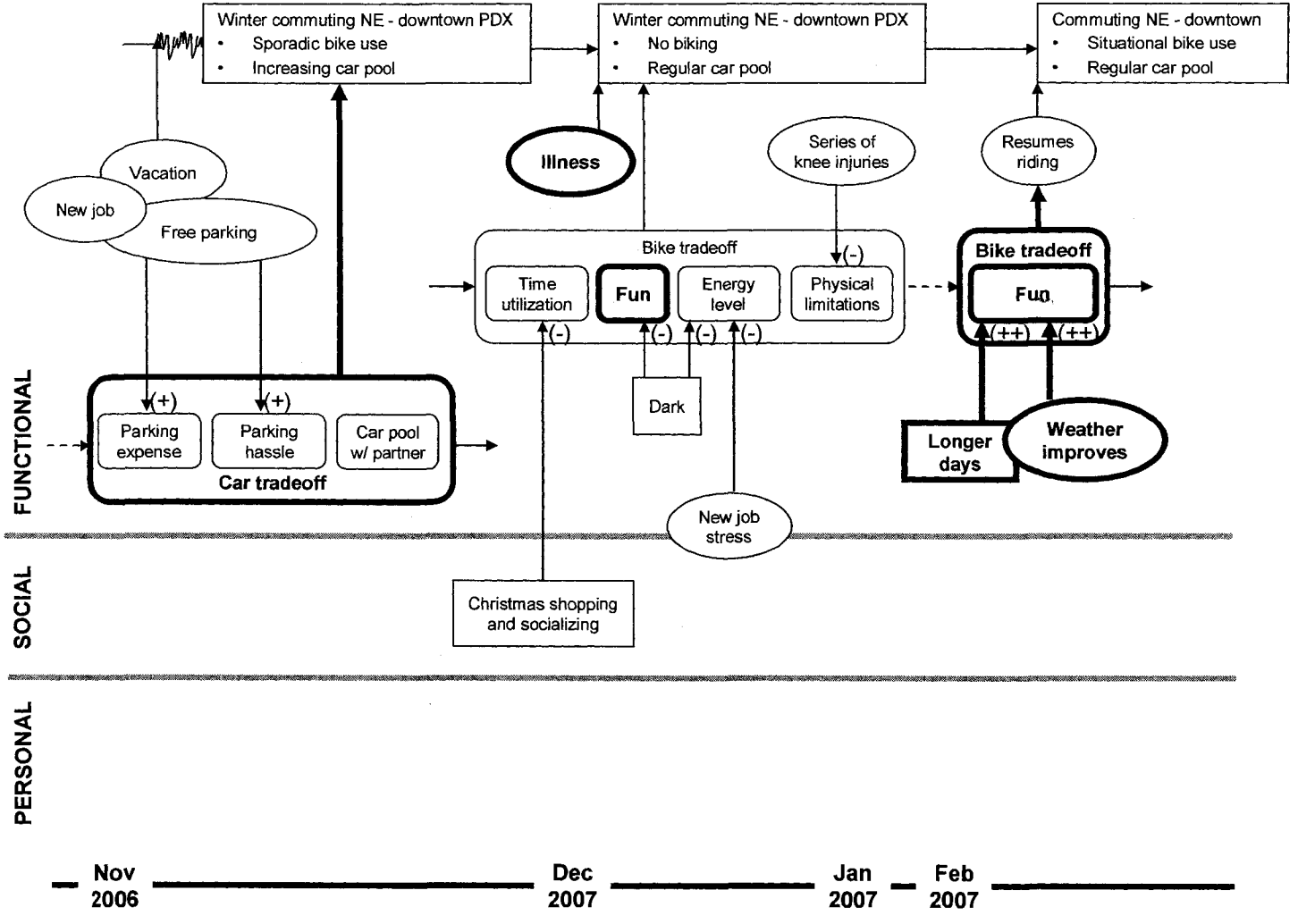

College – lives near PSU
• Walks to campus
Commuting downtown PDX
• Bus + walking
Moves to Portland
New job
Expensive
Traffic hassles
Parking hassles
Driving tradeoff
Buys current bike
Waterfront crowded
Hills and traffic
Unpleasant social encounters
Poorly fitted bikes
Bike tradeoff
(-)
(-)
Owns series of bikes
FUNCTIONAL
SOCIAL
PERSONAL
Recreational biking
1996
2000
Summer 2005


Commuting downtown PDX
• Walking + bus
Commuting NE - downtown PDX
• Walking + bus (w/ transfer)
Commuting NE - downtown PDX
• Habitual bike use
Moves to NE PDX
Begins bike commuting
(-)
Unpleasant social encounters
Bus tradeoff
(--)
Time utilization
Reliability
Availability
Bus tradeoff
Time utilization
Fun
Exercise
Bike tradeoff
(++)
Ride to Work Day with friend
Bike identity
FUNCTIONAL
SOCIAL
PERSONAL
Summer 2005
Spring 2006
May 2006

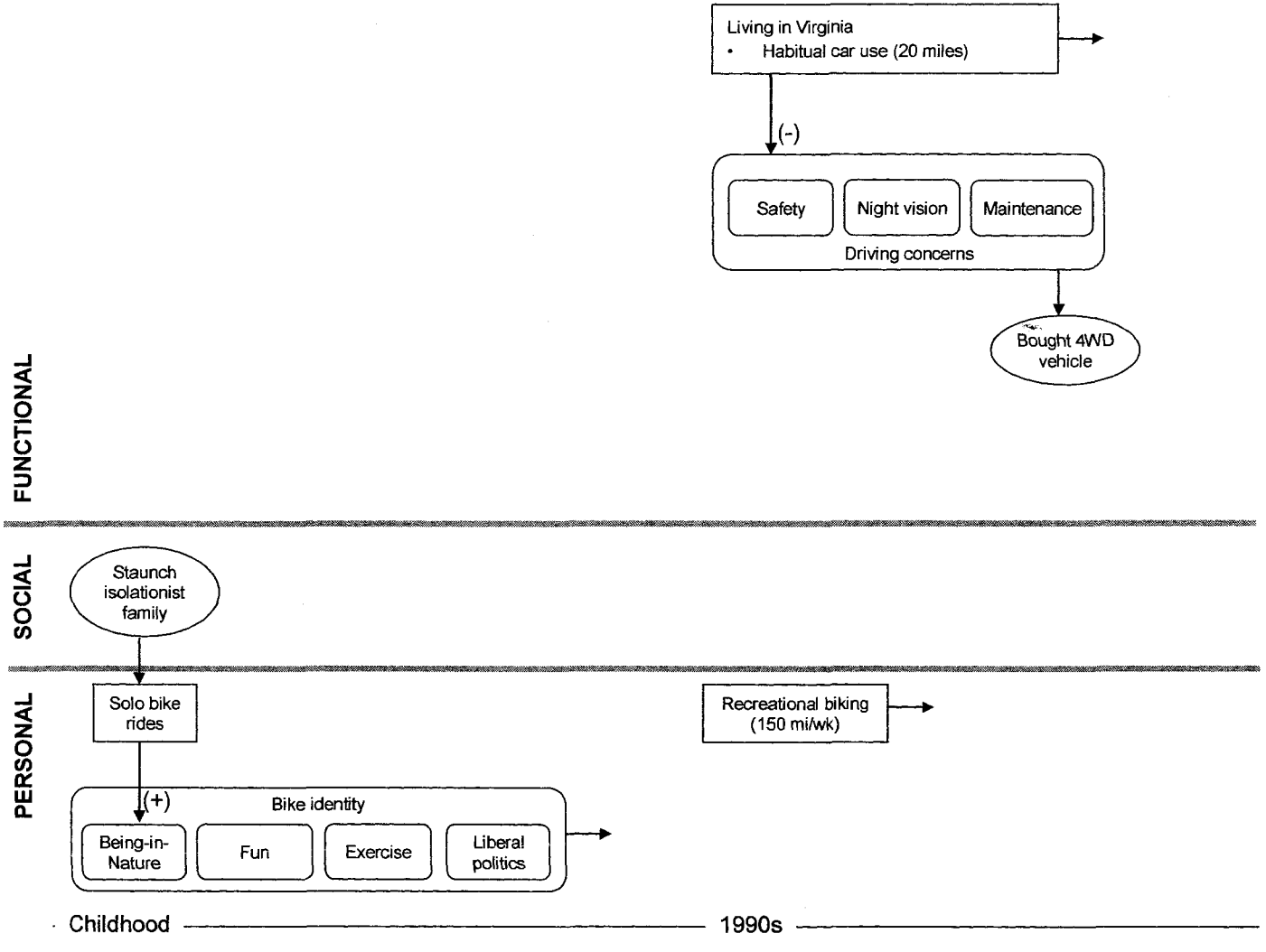
22/4


Commuting NE - downtown PDX
• Habitual bike use
Winter commuting NE - downtown PDX
• Habitual bike use
Decides to bike thru winter
(+)
Bike tradeoff
Personal Appearance
Fun
Time Utilization
(-)
(+)
(+)
(+)
Buys rain pants
Refines route
Rain
Bike tradeoff
Fun
Safety
Time Utilization
(-)
(-)
(-)
Buys rain gear
Heavy rains
FUNCTIONAL
SOCIAL
Begins bike commuting with partner
PERSONAL
Summer 2006
Sept 2006

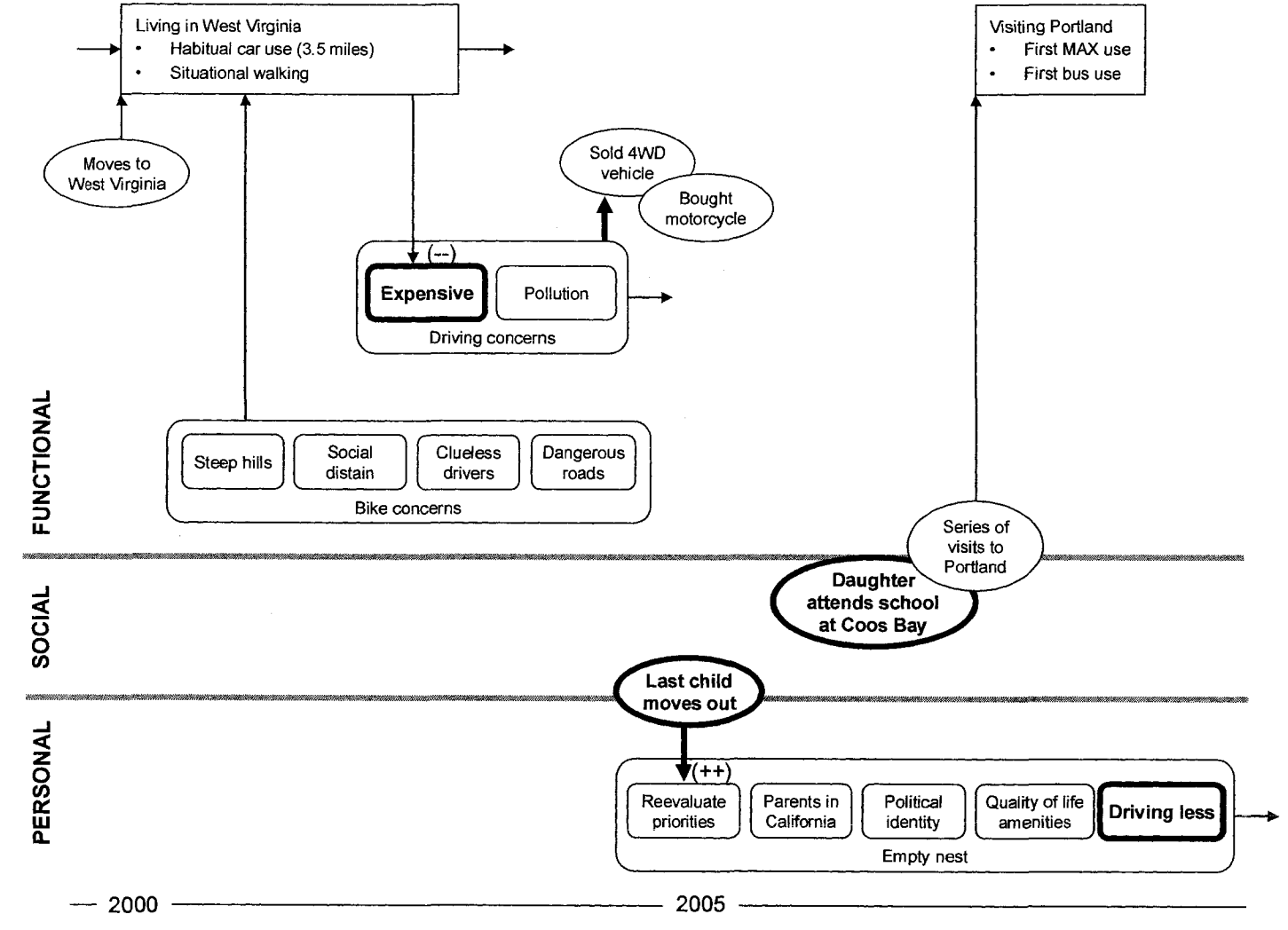

Rain
Cold
Dark
(-)
Economical
Limited cargo
Time utilization
Body temperature
Fun
Safety
Maintenance
Personal accomplishment
Bike tradeoff
(+)
(+)
Tight finances
Sold 2nd house
Gas prices ease down
Kudos from coworkers
FUNCTIONAL
SOCIAL
PERSONAL
Oct 2006
Nov 2006

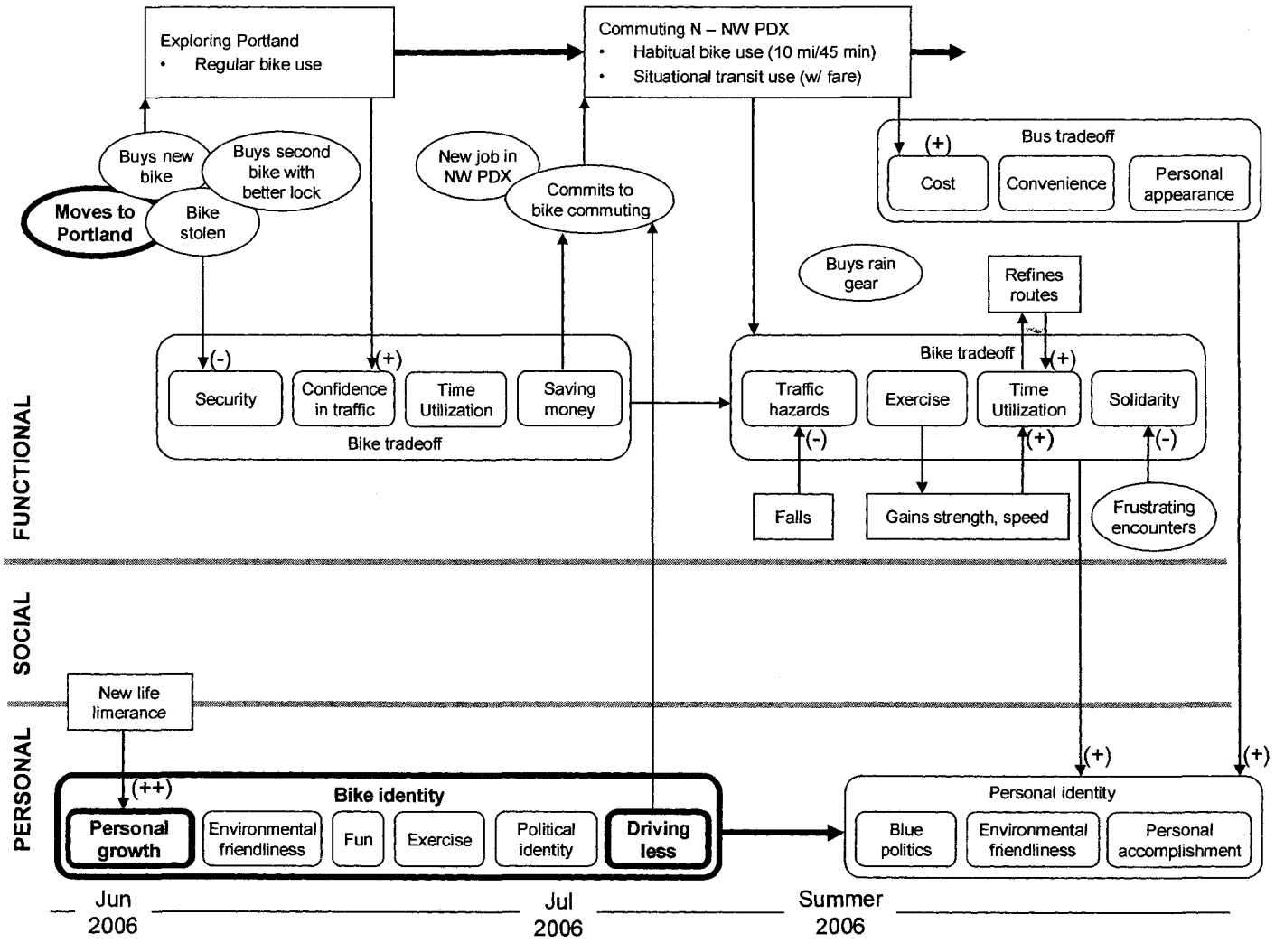

Winter commuting NE - downtown PDX
• Sporadic bike use
• Increasing car pool
Winter commuting NE - downtown PDX
• No biking
• Regular car pool
Commuting NE - downtown
• Situational bike use
• Regular car pool
Illness
Series of knee injuries
Resumes riding
Vacation
New job
Free parking
Bike tradeoff
Time utilization
Fun
Energy level
Physical limitations
Bike tradeoff
Fun
(-)
(++)
(++)
(+)
(+)
Parking expense
Parking hassle
Car pool w/ partner
Car tradeoff
Dark
Longer days
Weather improves
New job stress
Christmas shopping and socializing
FUNCTIONAL
SOCIAL
PERSONAL
Nov 2006
Dec 2007
Jan 2007
Feb 2007

(437)

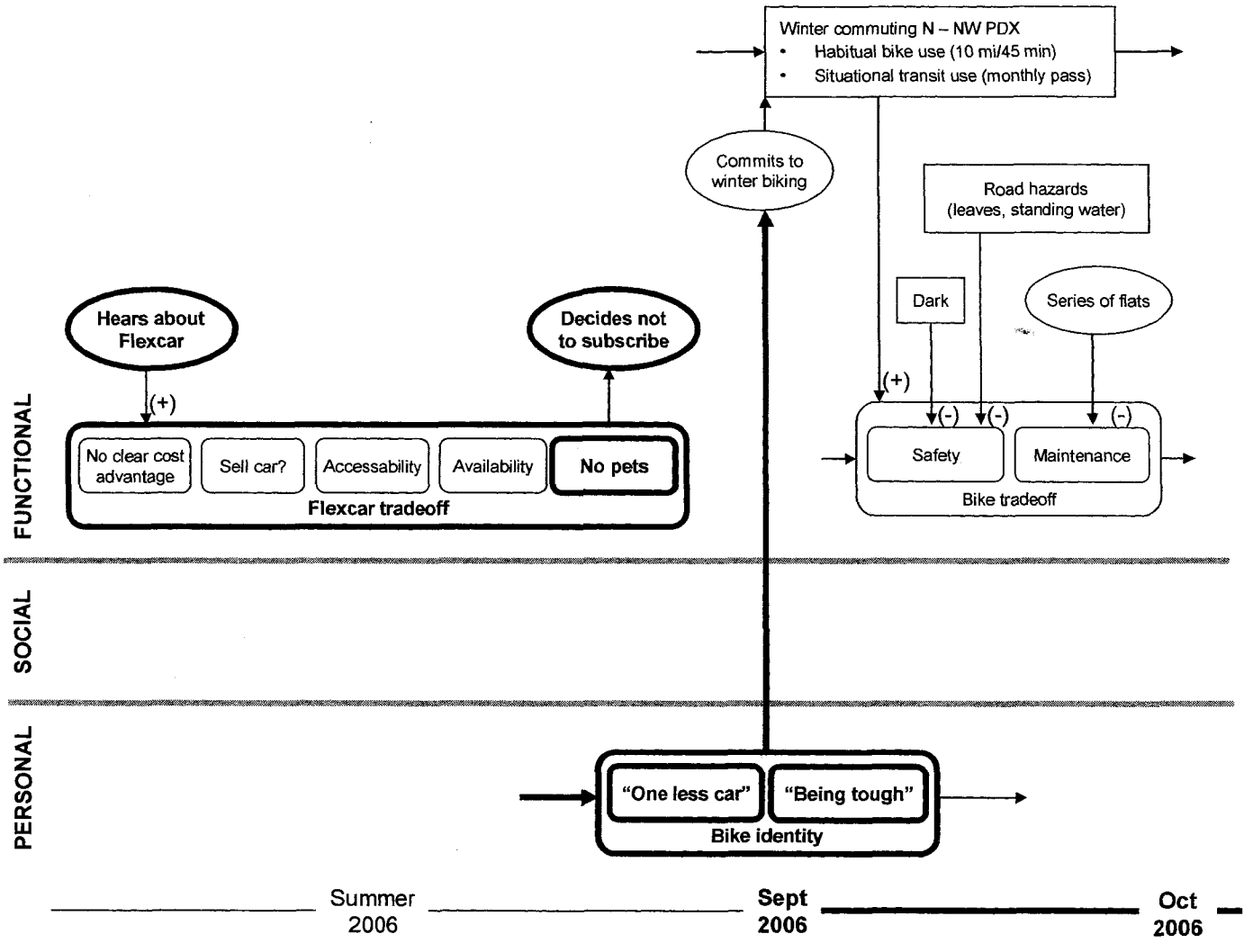

Living in Virginia
• Habitual car use (20 miles)
(-)
Safety
Night vision
Maintenance
Driving concerns
Bought 4WD vehicle
FUNCTIONAL
SOCIAL
PERSONAL
Staunch isolationist family
Solo bike rides
Recreational biking (150 mi/wk)
(+)
Bike identity
Being-in-Nature
Fun
Exercise
Liberal politics
Childhood
1990s

23/2

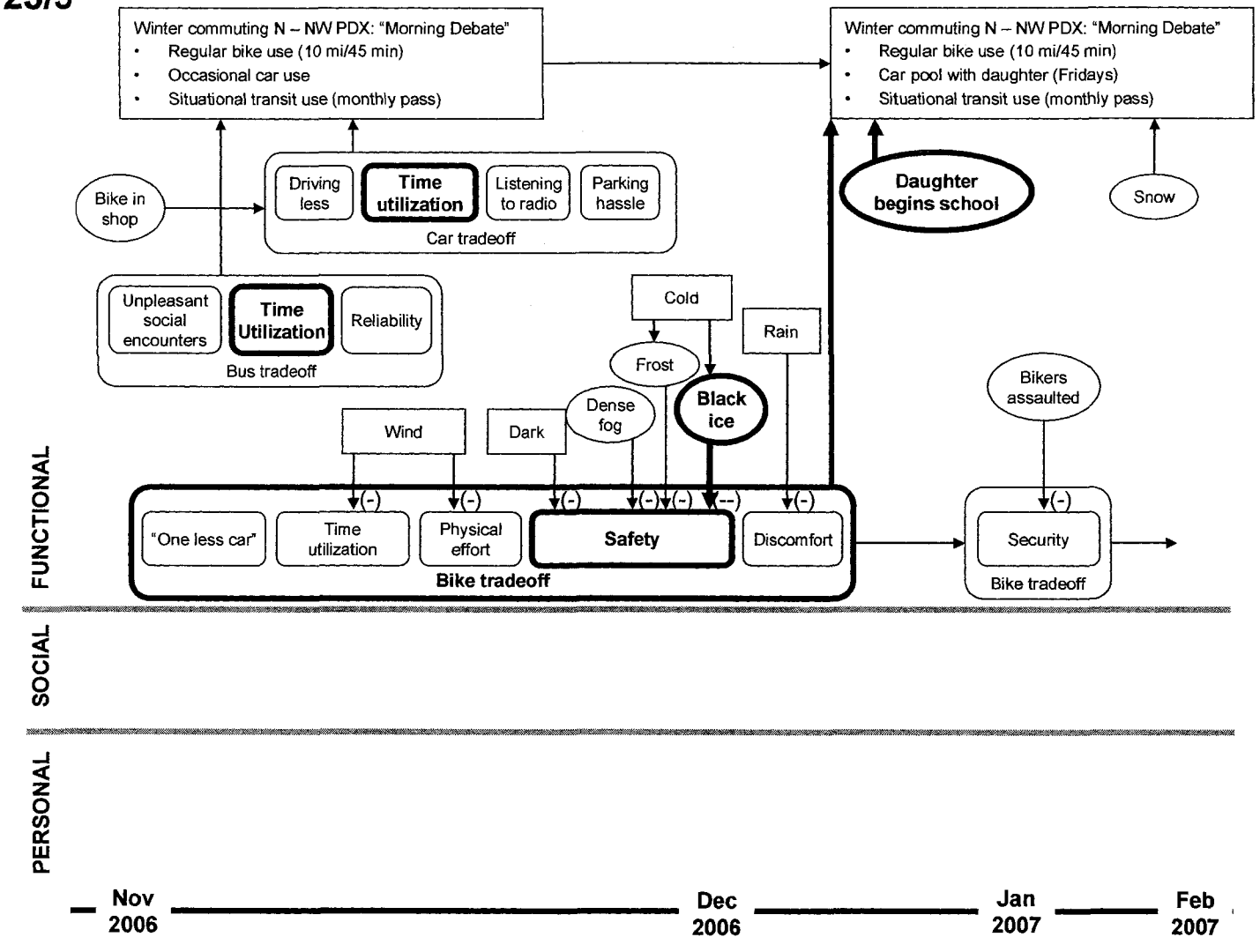

Living in West Virginia
• Habitual car use (3.5 miles)
• Situational walking
Visiting Portland
• First MAX use
• First bus use
Moves to West Virginia
Sold 4WD vehicle
Bought motorcycle
(--)
Expensive
Pollution
Driving concerns
Steep hills
Social distain
Clueless drivers
Dangerous roads
Bike concerns
FUNCTIONAL
Series of visits to Portland
Daughter attends school at Coos Bay
SOCIAL
Last child moves out
(++)
Reevaluate priorities
Parents in California
Political identity
Quality of life amenities
Driving less
Empty nest
PERSONAL
2000
2005


Exploring Portland
• Regular bike use
Commuting N – NW PDX
• Habitual bike use (10 mi/45 min)
• Situational transit use (w/ fare)
Buys new bike
Buys second bike with better lock
Moves to Portland
Bike stolen
New job in NW PDX
Commits to bike commuting
(+)
Bus tradeoff
Cost
Convenience
Personal appearance
Buys rain gear
Refines routes
(-)
Security
(+)
Confidence in traffic
Time Utilization
Saving money
Bike tradeoff
Bike tradeoff
Traffic hazards
Exercise
(+)
Time Utilization
Solidarity
(-)
(+)
(-)
Falls
Gains strength, speed
Frustrating encounters
FUNCTIONAL
SOCIAL
PERSONAL
New life limerance
(++)
Bike identity
Personal growth
Environmental friendliness
Fun
Exercise
Political identity
Driving less
(+)
(+)
Personal identity
Blue politics
Environmental friendliness
Personal accomplishment
Jun 2006
Jul 2006
Summer 2006

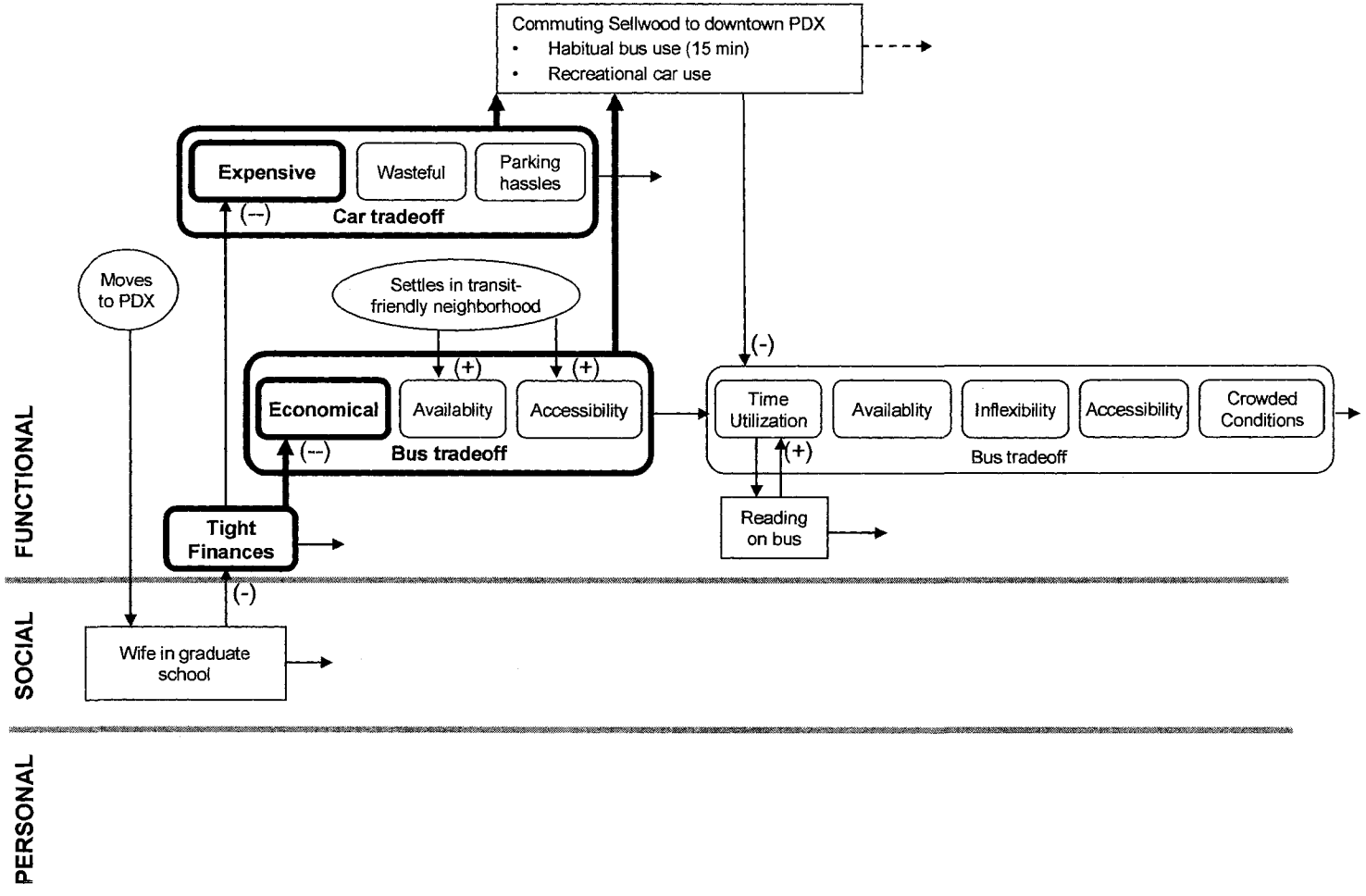
(440)


Winter commuting N – NW PDX
• Habitual bike use (10 mi/45 min)
• Situational transit use (monthly pass)
Commits to winter biking
Road hazards (leaves, standing water)
Dark
Series of flats
Hears about Flexcar
Decides not to subscribe
(+)
(+)
(-)
(-)
(-)
No clear cost advantage
Sell car?
Accessability
Availability
No pets
Flexcar tradeoff
Safety
Maintenance
Bike tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
"One less car"
"Being tough"
Bike identity
Summer 2006
Sept 2006
Oct 2006

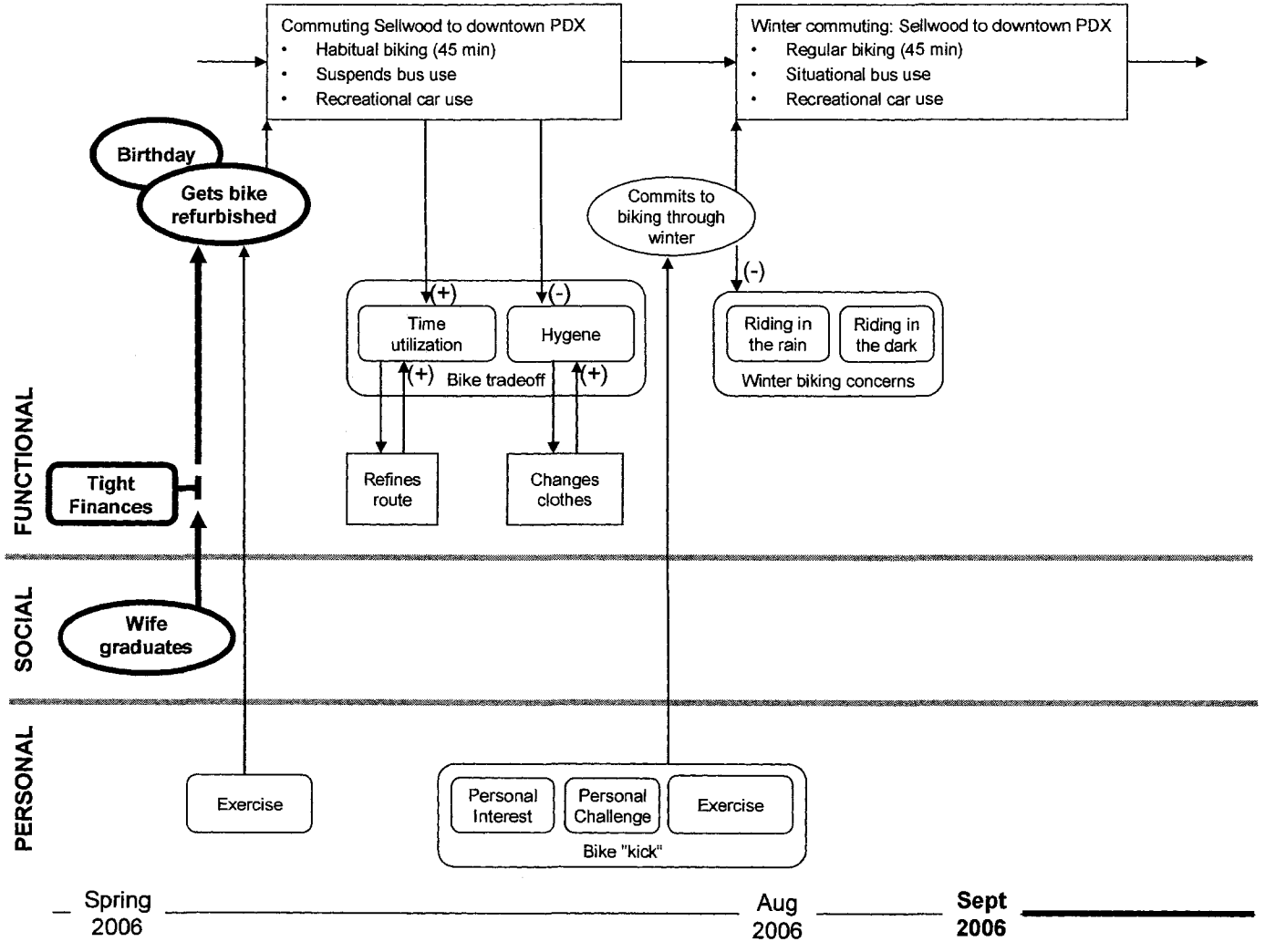
23/5


Winter commuting N – NW PDX: "Morning Debate"
• Regular bike use (10 mi/45 min)
• Occasional car use
• Situational transit use (monthly pass)
Winter commuting N – NW PDX: "Morning Debate"
• Regular bike use (10 mi/45 min)
• Car pool with daughter (Fridays)
• Situational transit use (monthly pass)
Bike in shop
Driving less
Time utilization
Listening to radio
Parking hassle
Car tradeoff
Daughter begins school
Snow
Unpleasant social encounters
Time Utilization
Reliability
Bus tradeoff
Cold
Rain
Frost
Dense fog
Black ice
Bikers assaulted
Wind
Dark
"One less car"
Time utilization
Physical effort
Safety
Discomfort
Bike tradeoff
Security
Bike tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
Nov 2006
Dec 2006
Jan 2007
Feb 2007

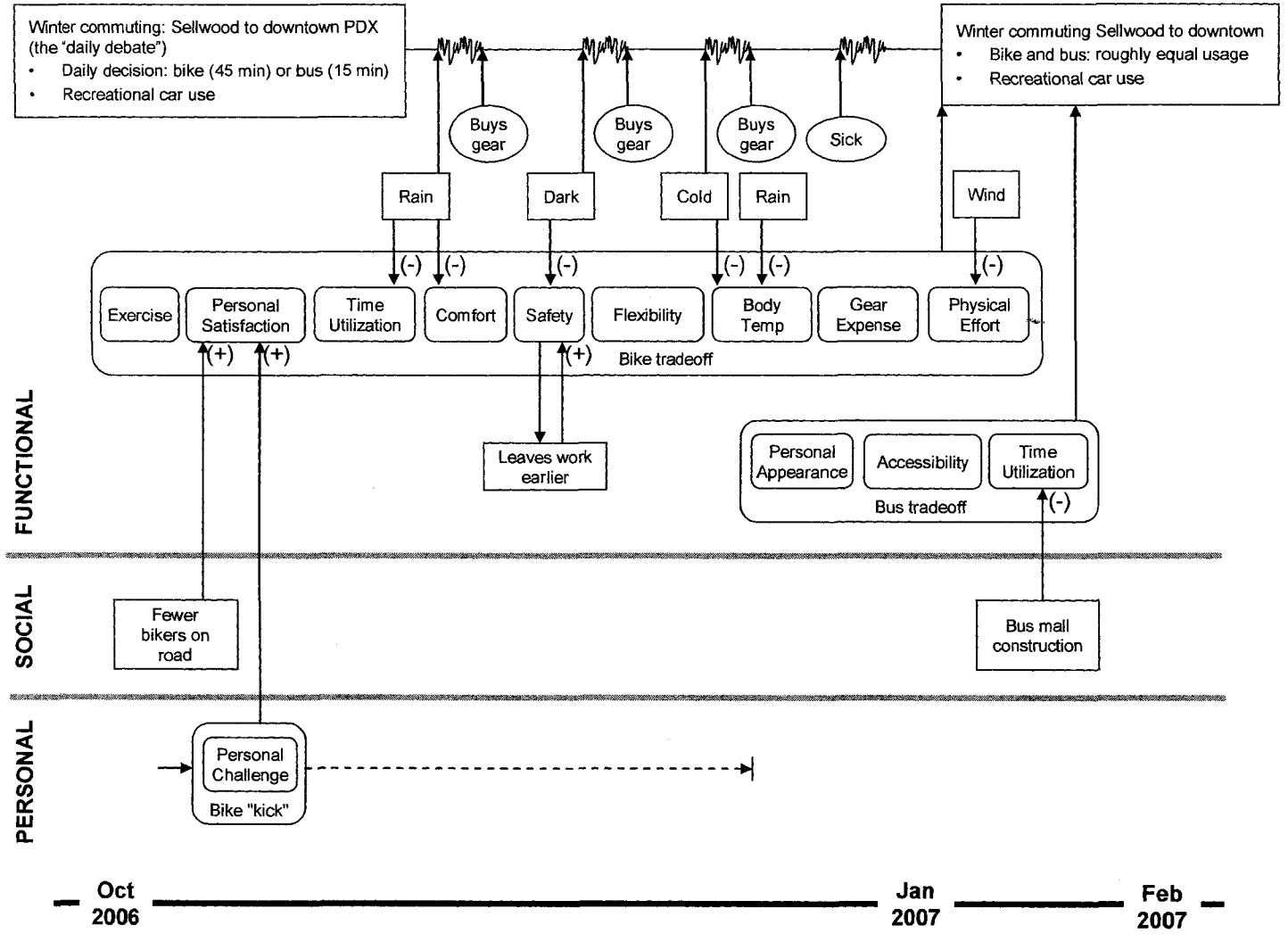
25/1

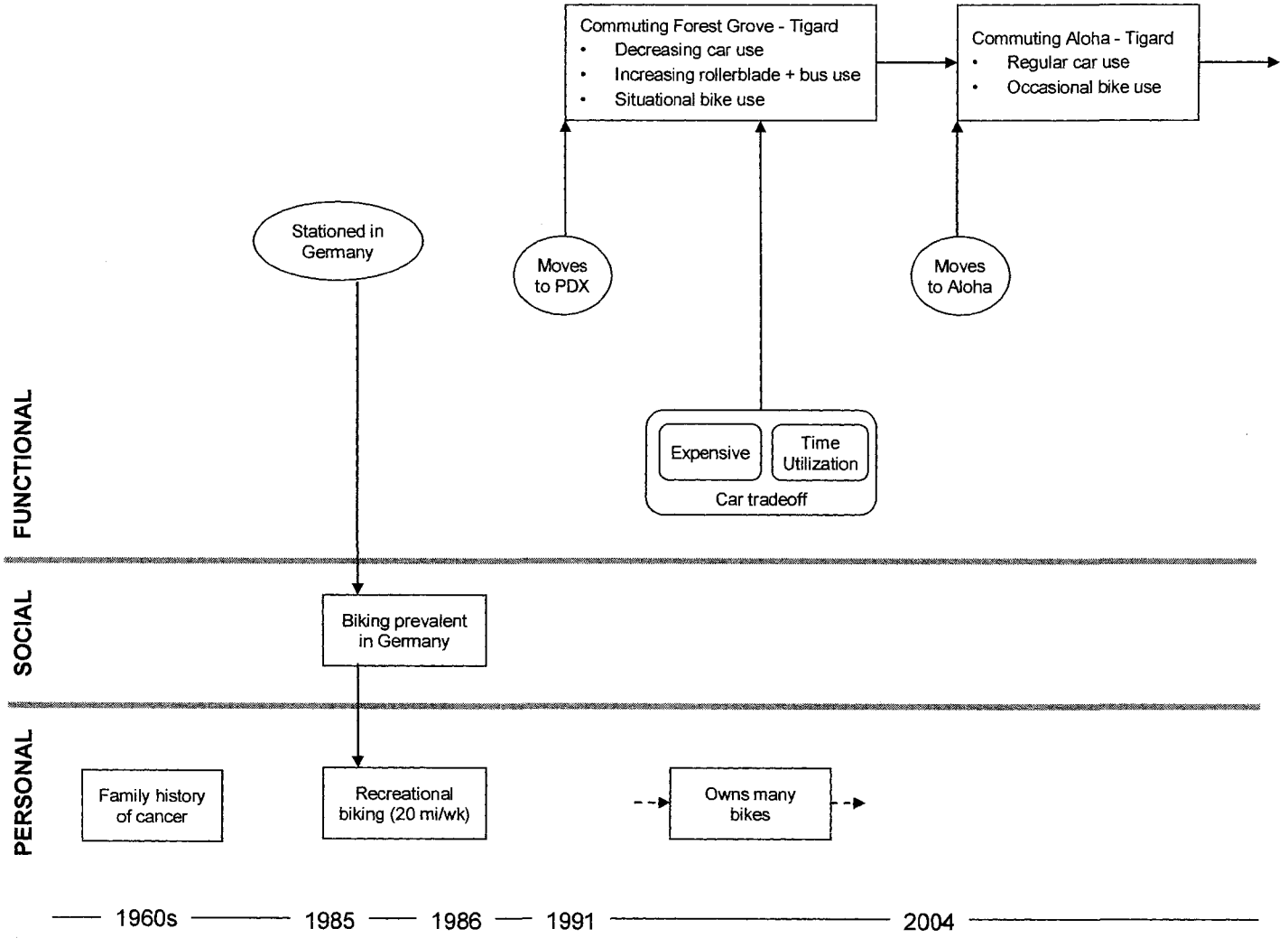

Commuting Sellwood to downtown PDX
• Habitual bus use (15 min)
• Recreational car use
Expensive
Wasteful
Parking hassles
(--)
Car tradeoff
Moves to PDX
Settles in transit-friendly neighborhood
(+)
(+)
Economical
Availablity
Accessibility
(--)
Bus tradeoff
(-)
Time Utilization
Availablity
Inflexibility
Accessibility
Crowded Conditions
(+)
Bus tradeoff
Reading on bus
Tight Finances
(-)
Wife in graduate school
FUNCTIONAL
SOCIAL
PERSONAL
2004
Fall 2004

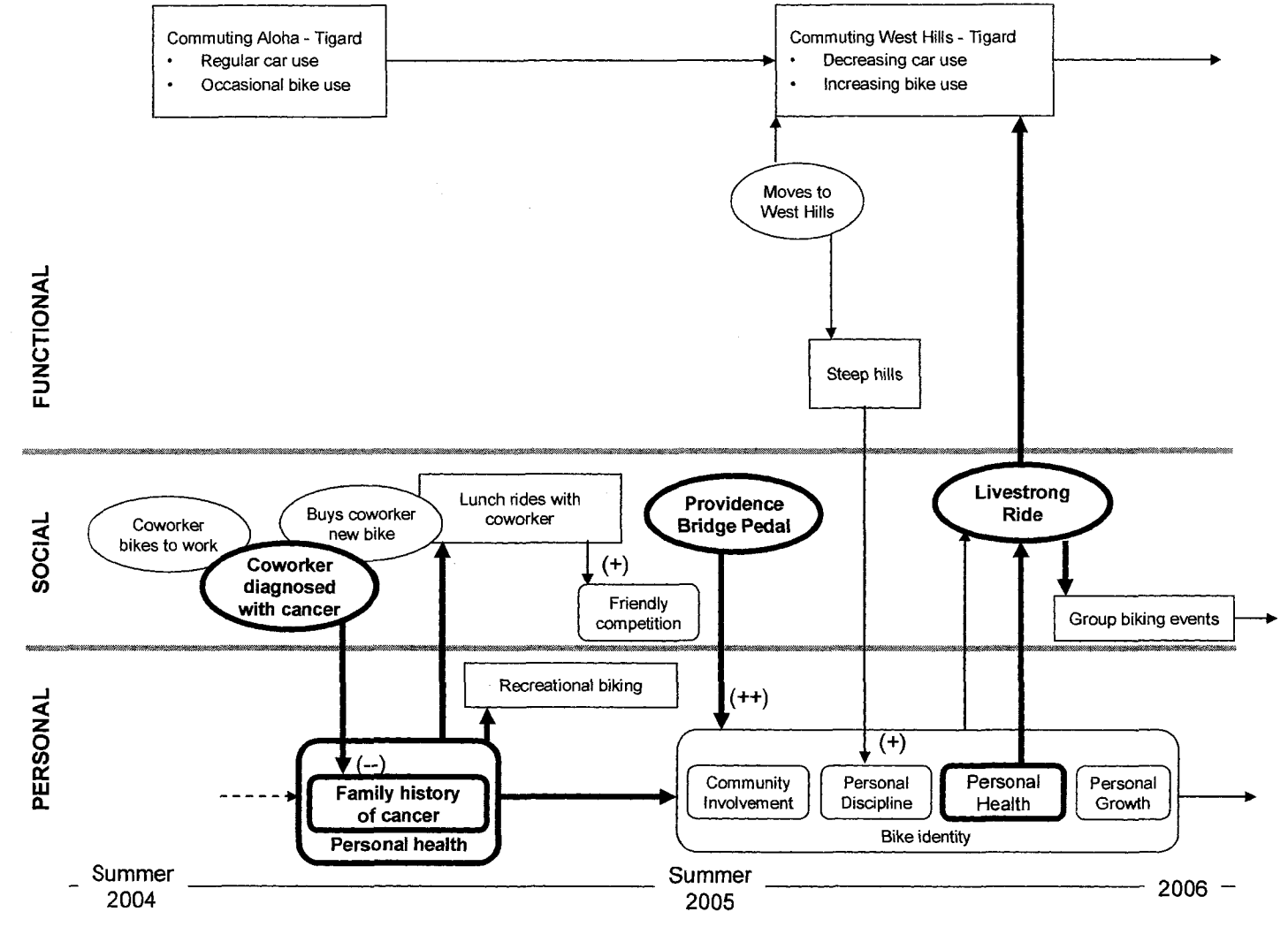
25/2
PERSONAL
SOCIAL
FUNCTIONAL
Commuting Sellwood to downtown PDX
Experiments with bike + bus (20-30 min)
Recreational car use
Bus tradeoff
Buys fixie at yard sale
1st ride in downtown traffic
Discovers Springwater Trail
Bike ill-suited to commuting
Time utilization
Physical effort
Hygene
Bike tradeoff
Discontinues biking
Commuting Sellwood to downtown PDX
Habitual bus use (15 min)
Recreational car use
Coworker bikes to work
Self-discipline
Bike tradeoff
(+)
Wife in graduate school
Tight Finances
(-)
(+)
(+)
Fall 2004

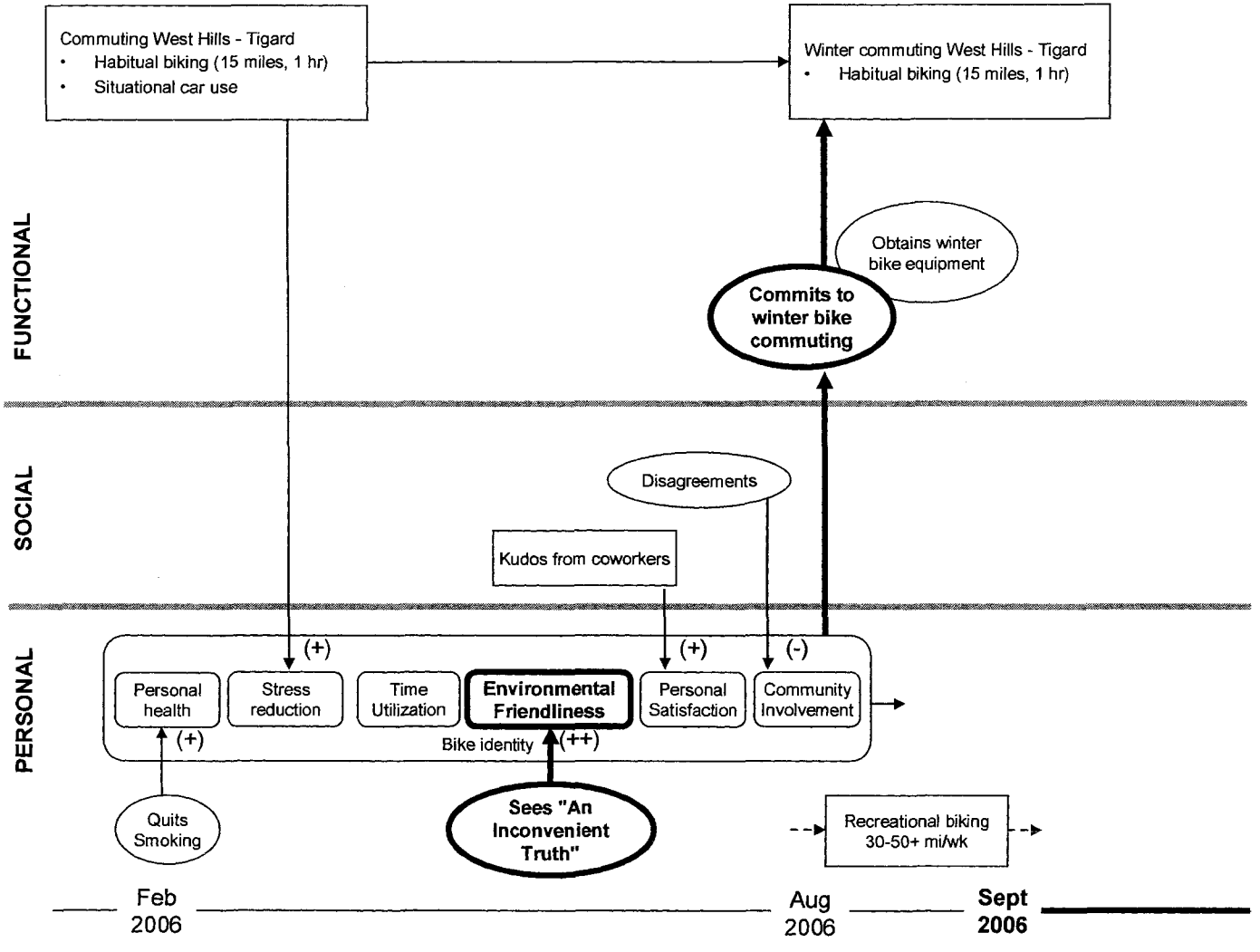

Commuting Sellwood to downtown PDX
• Habitual biking (45 min)
• Suspends bus use
• Recreational car use
Winter commuting: Sellwood to downtown PDX
• Regular biking (45 min)
• Situational bus use
• Recreational car use
Birthday
Gets bike refurbished
Commits to biking through winter
(+)
(-)
Time utilization
Hygene
(+)
Bike tradeoff
(+)
Riding in the rain
Riding in the dark
Winter biking concerns
Refines route
Changes clothes
FUNCTIONAL
Tight Finances
SOCIAL
Wife graduates
PERSONAL
Exercise
Personal Interest
Personal Challenge
Exercise
Bike "kick"
Spring 2006
Aug 2006
Sept 2006

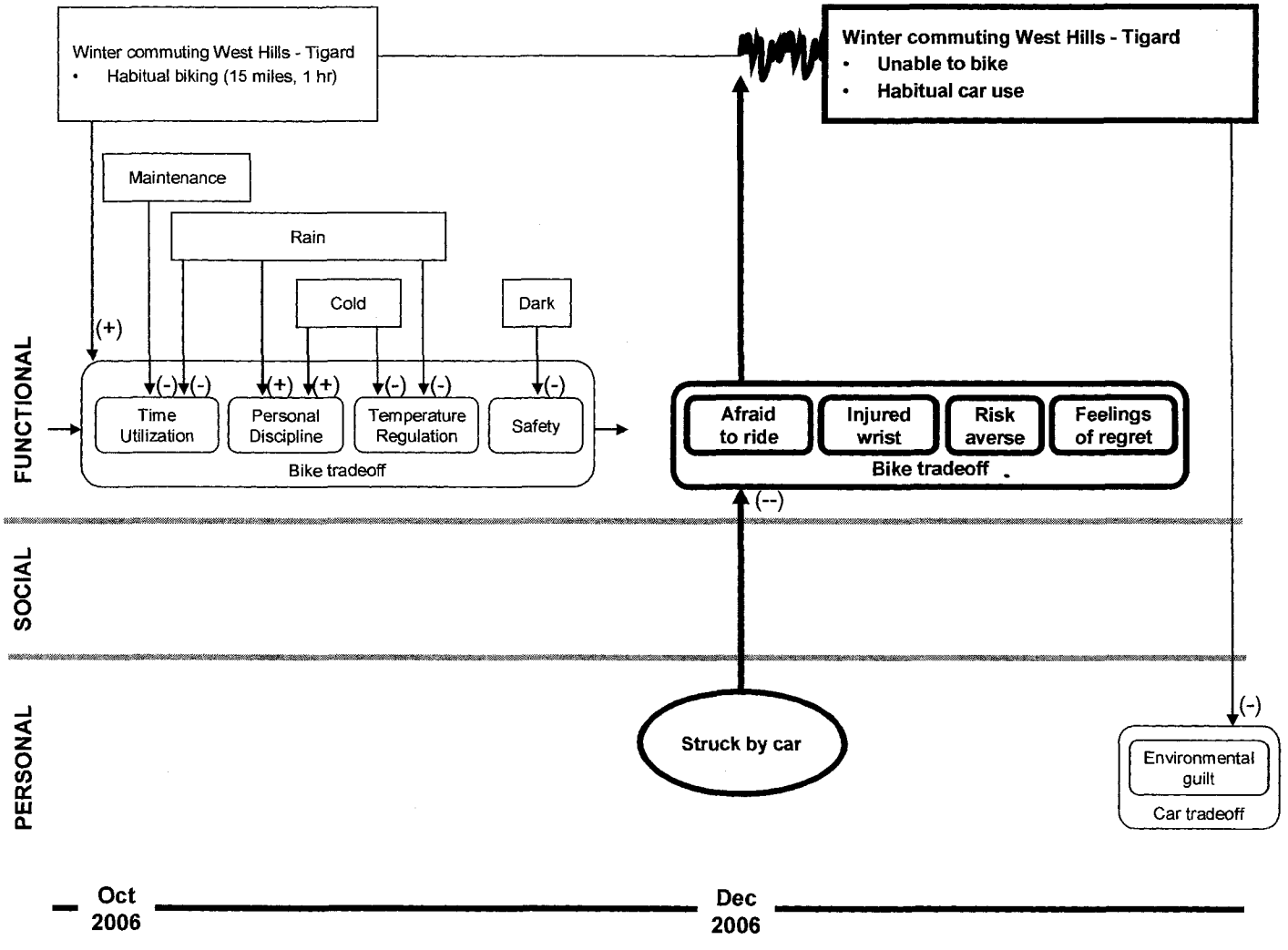
25/4


Winter commuting: Sellwood to downtown PDX (the "daily debate")
• Daily decision: bike (45 min) or bus (15 min)
• Recreational car use
Winter commuting Sellwood to downtown
• Bike and bus: roughly equal usage
• Recreational car use
Buys gear
Buys gear
Buys gear
Sick
Rain
Dark
Cold
Rain
Wind
(-)
Exercise
Personal Satisfaction
Time Utilization
Comfort
Safety
Flexibility
Body Temp
Gear Expense
Physical Effort
(+)
Bike tradeoff
Leaves work earlier
Personal Appearance
Accessibility
Time Utilization
Bus tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
Fewer bikers on road
Bus mall construction
Personal Challenge
Bike "kick"
Oct 2006
Jan 2007
Feb 2007


Commuting Forest Grove - Tigard
• Decreasing car use
• Increasing rollerblade + bus use
• Situational bike use
Commuting Aloha - Tigard
• Regular car use
• Occasional bike use
Stationed in Germany
Moves to PDX
Moves to Aloha
Expensive
Time Utilization
Car tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
Biking prevalent in Germany
Family history of cancer
Recreational biking (20 mi/wk)
Owns many bikes
1960s
1985
1986
1991
2004


Commuting Aloha - Tigard
• Regular car use
• Occasional bike use
Commuting West Hills - Tigard
• Decreasing car use
• Increasing bike use
Moves to West Hills
Steep hills
FUNCTIONAL
SOCIAL
PERSONAL
Coworker bikes to work
Buys coworker new bike
Lunch rides with coworker
Coworker diagnosed with cancer
(+)
Friendly competition
Providence Bridge Pedal
Livestrong Ride
Group biking events
Recreational biking
(++)
(+)
(--)
Family history of cancer
Personal health
Community Involvement
Personal Discipline
Personal Health
Personal Growth
Bike identity
Summer 2004
Summer 2005
2006


Commuting West Hills - Tigard
• Habitual biking (15 miles, 1 hr)
• Situational car use
Winter commuting West Hills - Tigard
• Habitual biking (15 miles, 1 hr)
FUNCTIONAL
Obtains winter bike equipment
Commits to winter bike commuting
SOCIAL
Disagreements
Kudos from coworkers
PERSONAL
(+)
(+)
(-)
Personal health
Stress reduction
Time Utilization
Environmental Friendliness
Personal Satisfaction
Community Involvement
(+)
Bike identity
(++)
Quits Smoking
Sees "An Inconvenient Truth"
Recreational biking 30-50+ mi/wk
Feb 2006
Aug 2006
Sept 2006


Winter commuting West Hills - Tigard
• Habitual biking (15 miles, 1 hr)
Winter commuting West Hills - Tigard
• Unable to bike
• Habitual car use
Maintenance
Rain
Cold
Dark
(+)
(-)(-)
(+)(+)
(-)(-)
(-)
Time Utilization
Personal Discipline
Temperature Regulation
Safety
Bike tradeoff
Afraid to ride
Injured wrist
Risk averse
Feelings of regret
Bike tradeoff
(--)
FUNCTIONAL
SOCIAL
PERSONAL
Struck by car
(-)
Environmental guilt
Car tradeoff
Oct 2006
Dec 2006

(450)

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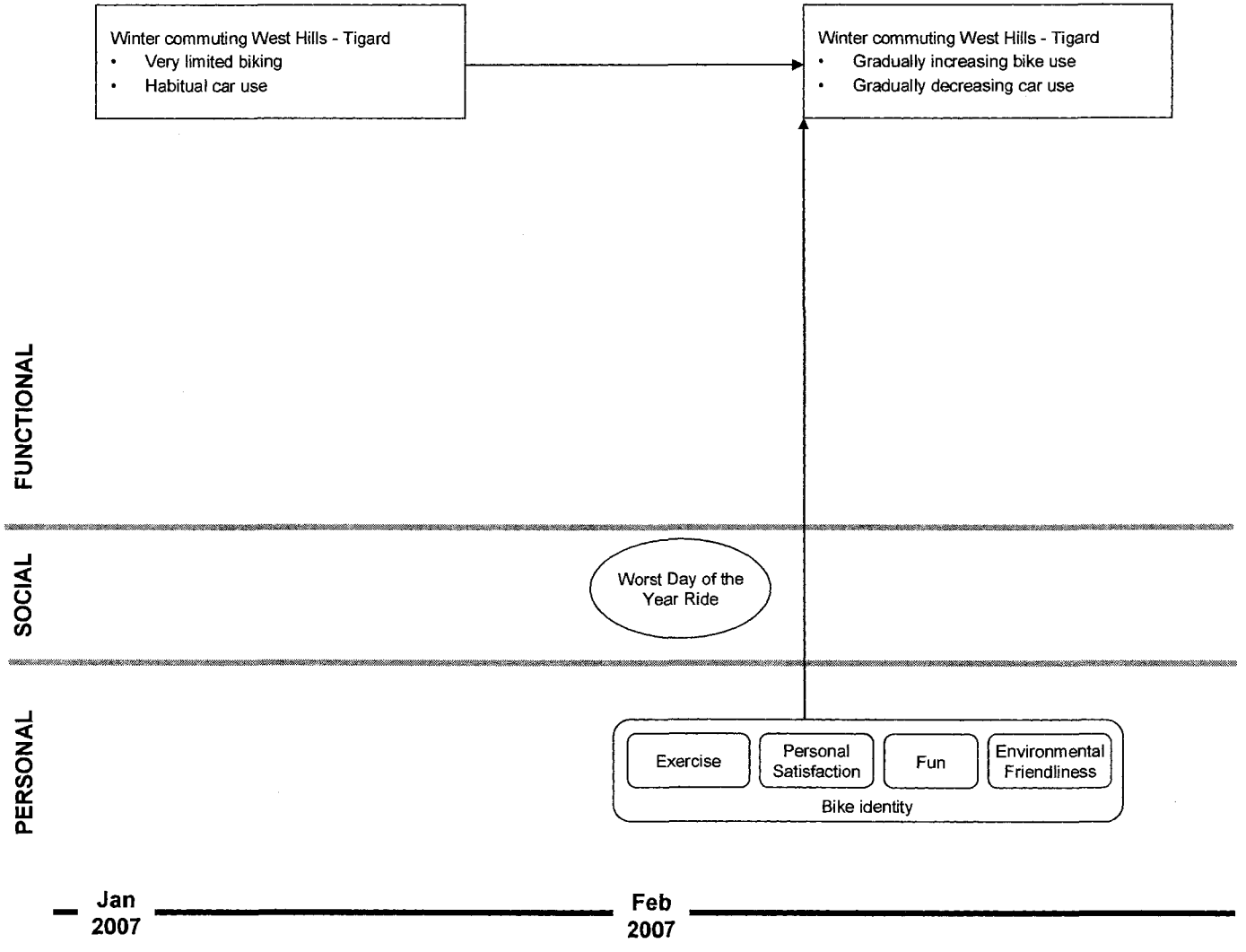
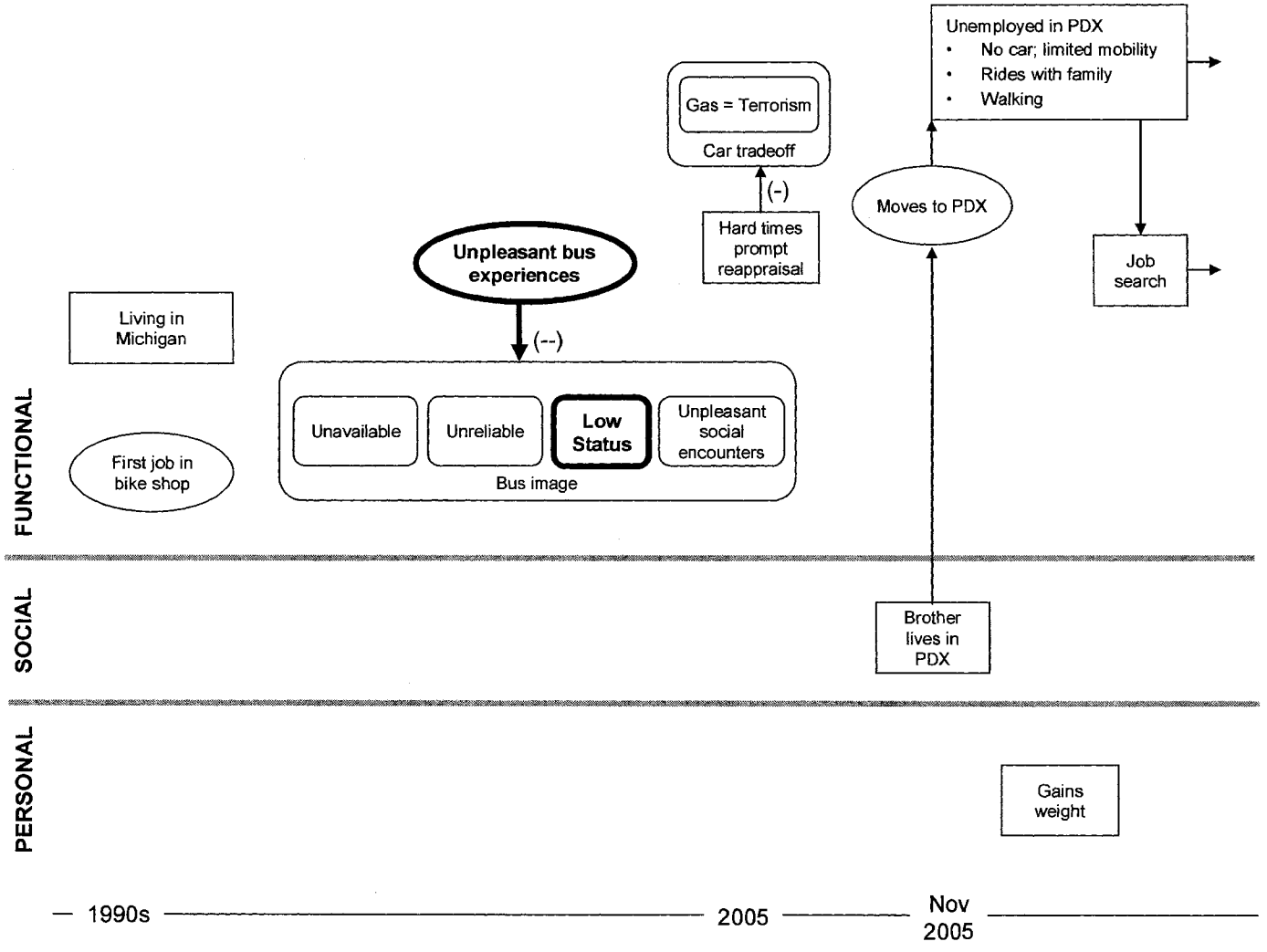
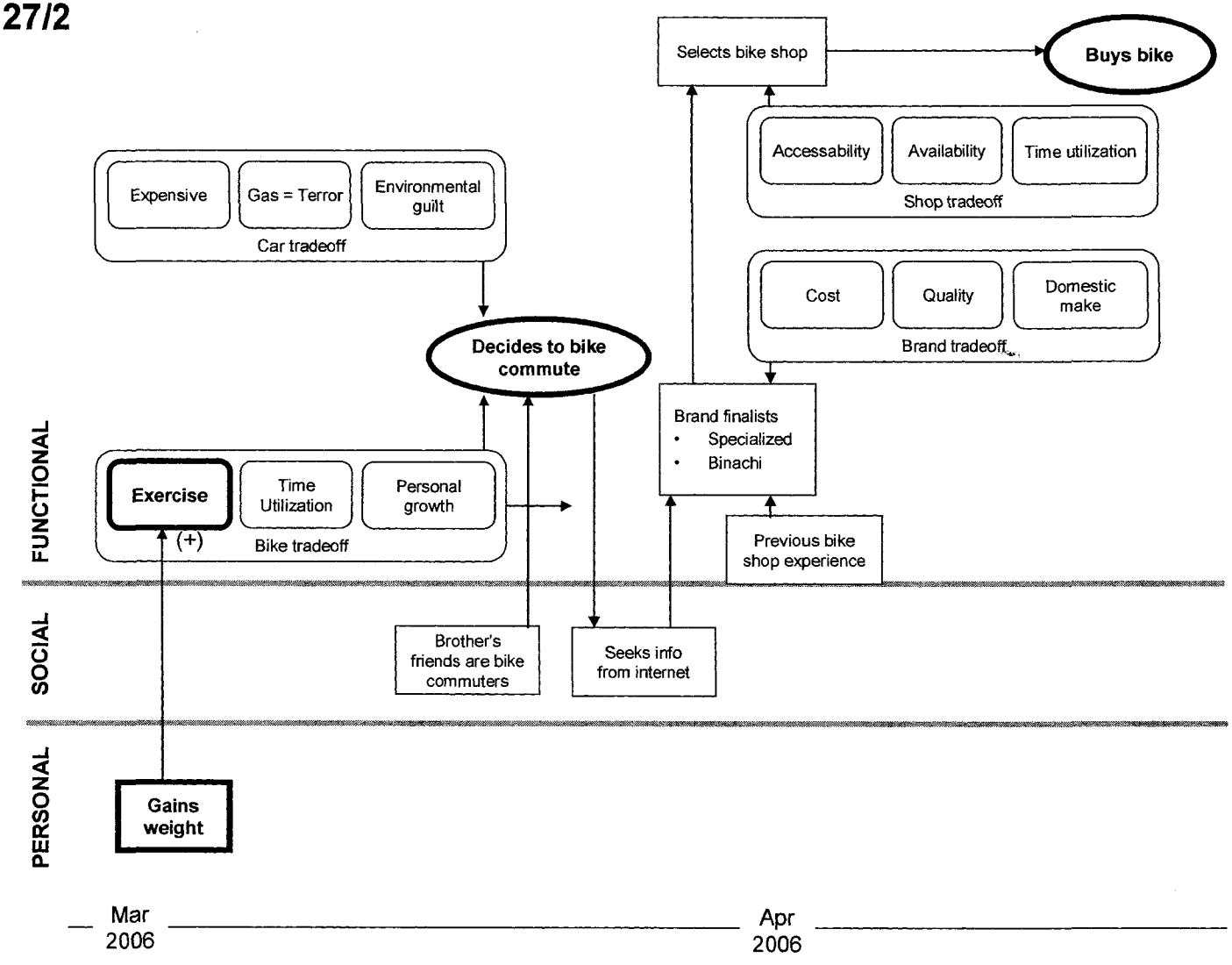
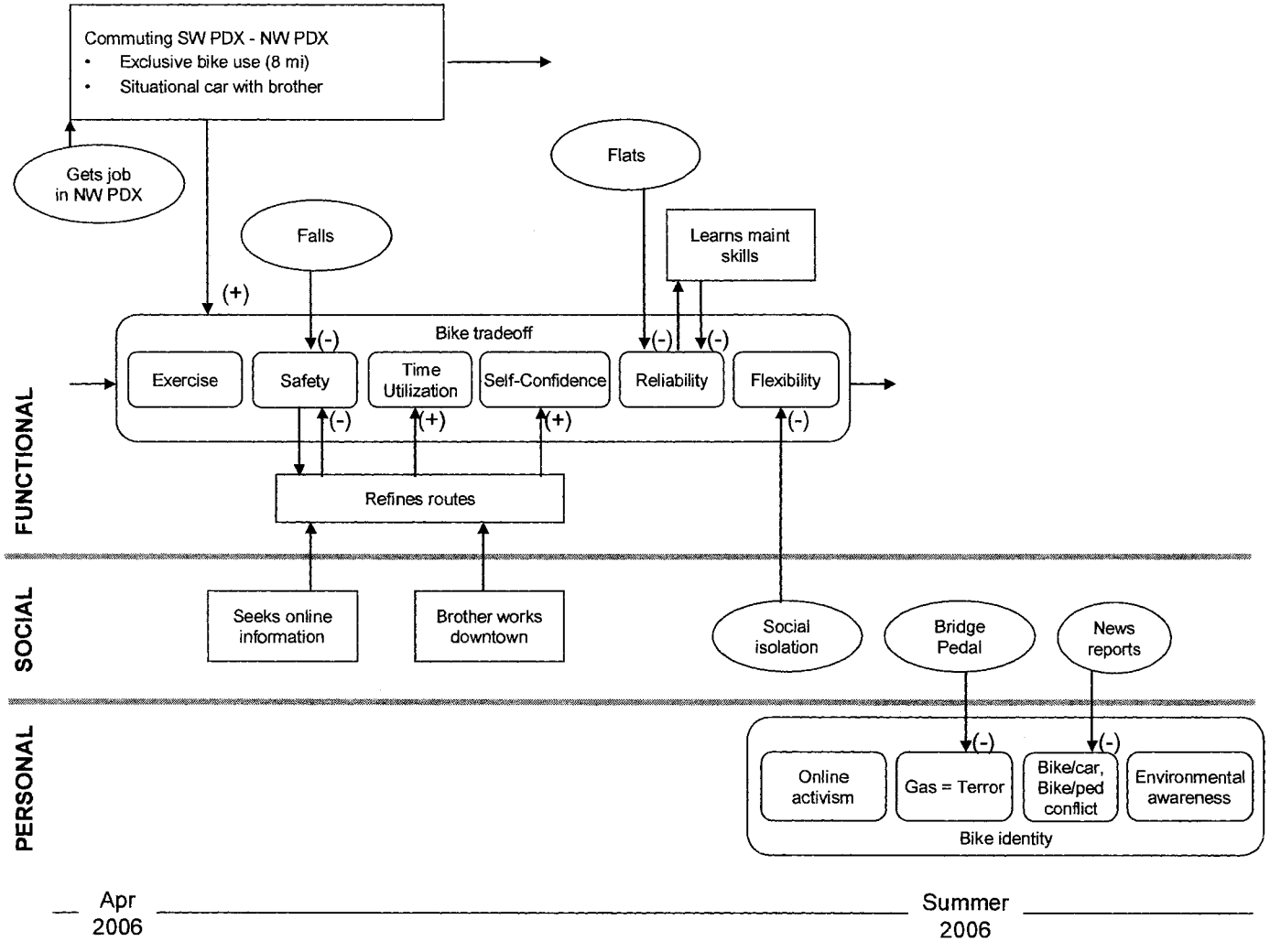

Winter commuting West Hills - Tigard
• Very limited biking
• Habitual car use
Winter commuting West Hills - Tigard
• Gradually increasing bike use
• Gradually decreasing car use
FUNCTIONAL
SOCIAL
PERSONAL
Worst Day of the Year Ride
Exercise
Personal Satisfaction
Fun
Environmental Friendliness
Bike identity
Jan 2007
Feb 2007

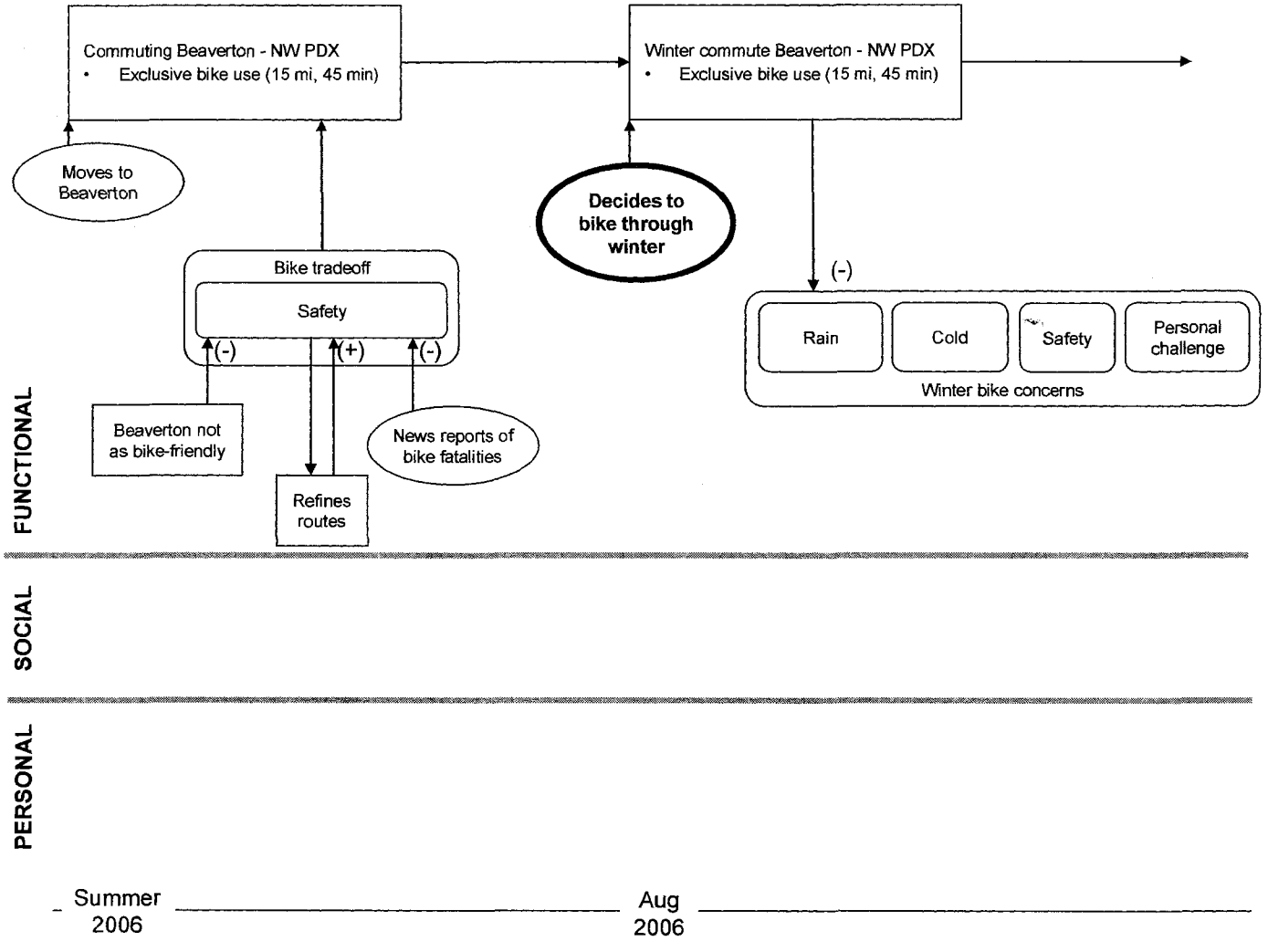

Unemployed in PDX
• No car; limited mobility
• Rides with family
• Walking
Gas = Terrorism
Car tradeoff
(-)
Hard times prompt reappraisal
Moves to PDX
Job search
Unpleasant bus experiences
(--)
Living in Michigan
Unavailable
Unreliable
Low Status
Unpleasant social encounters
Bus image
First job in bike shop
FUNCTIONAL
SOCIAL
Brother lives in PDX
PERSONAL
Gains weight
1990s
2005
Nov 2005

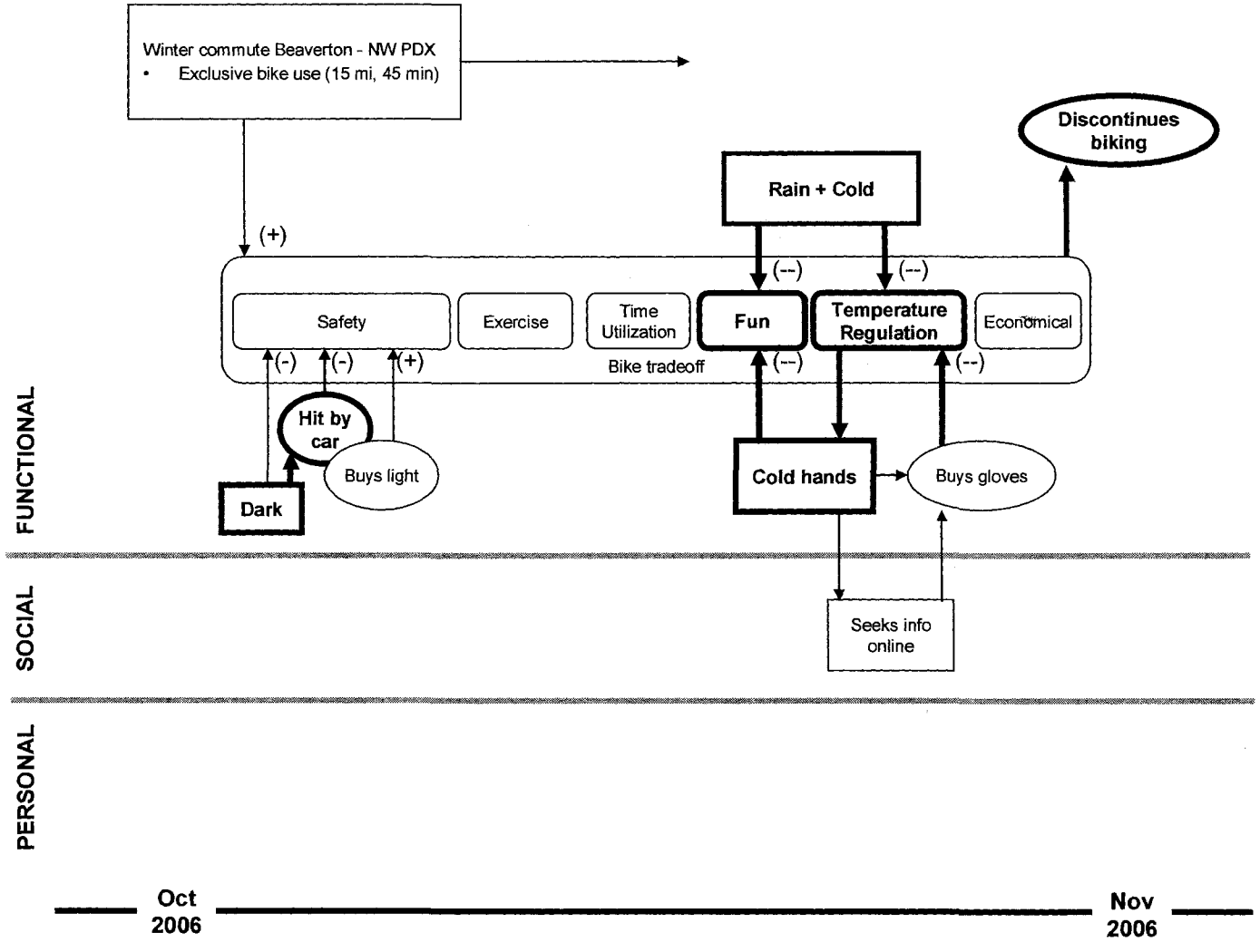
27/2

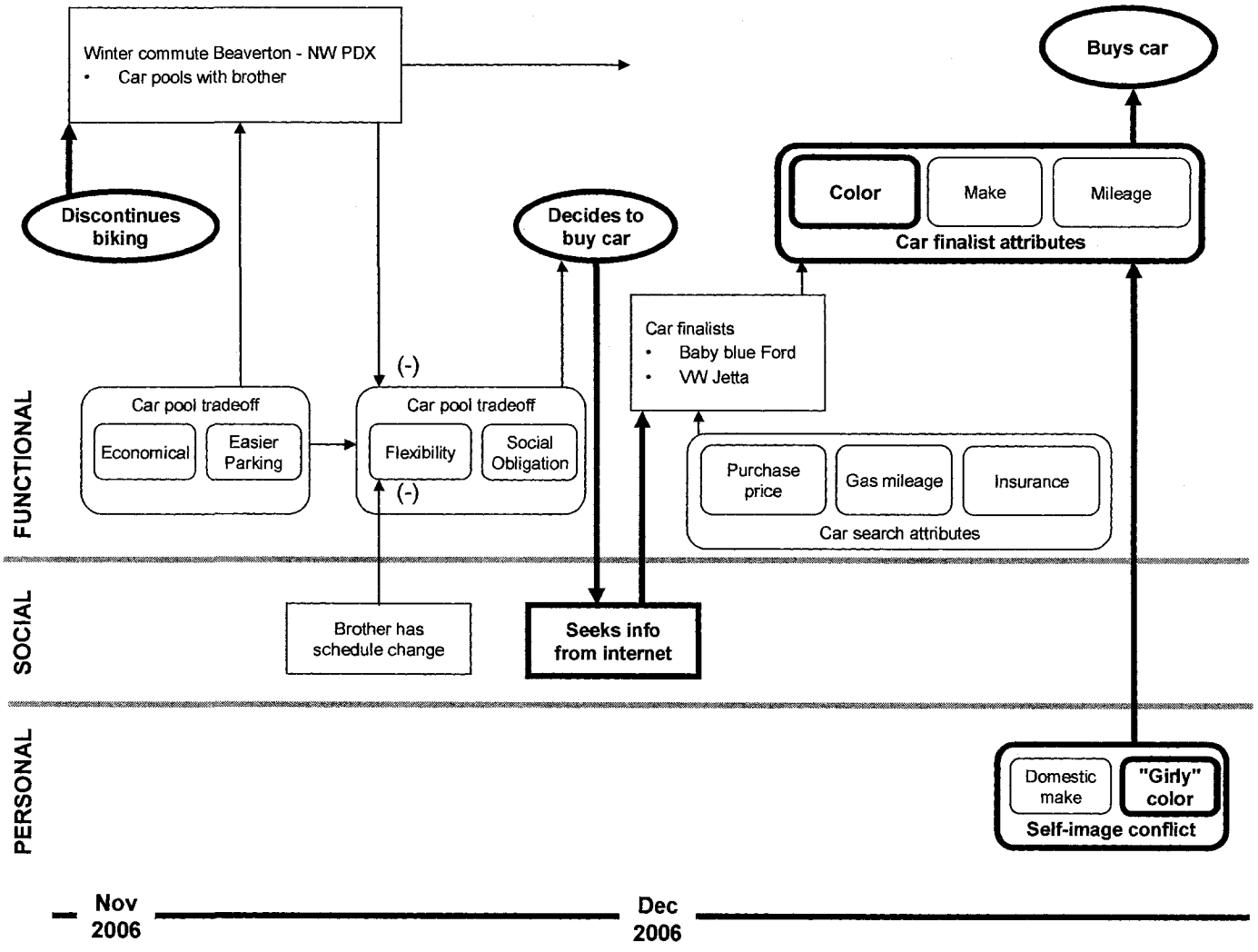

Selects bike shop
Buys bike
Accessability
Availability
Time utilization
Shop tradeoff
Expensive
Gas = Terror
Environmental guilt
Car tradeoff
Cost
Quality
Domestic make
Brand tradeoff
Decides to bike commute
Brand finalists
• Specialized
• Binachi
FUNCTIONAL
Exercise
(+)
Time Utilization
Personal growth
Bike tradeoff
Previous bike shop experience
SOCIAL
Brother's friends are bike commuters
Seeks info from internet
PERSONAL
Gains weight
Mar 2006
Apr 2006

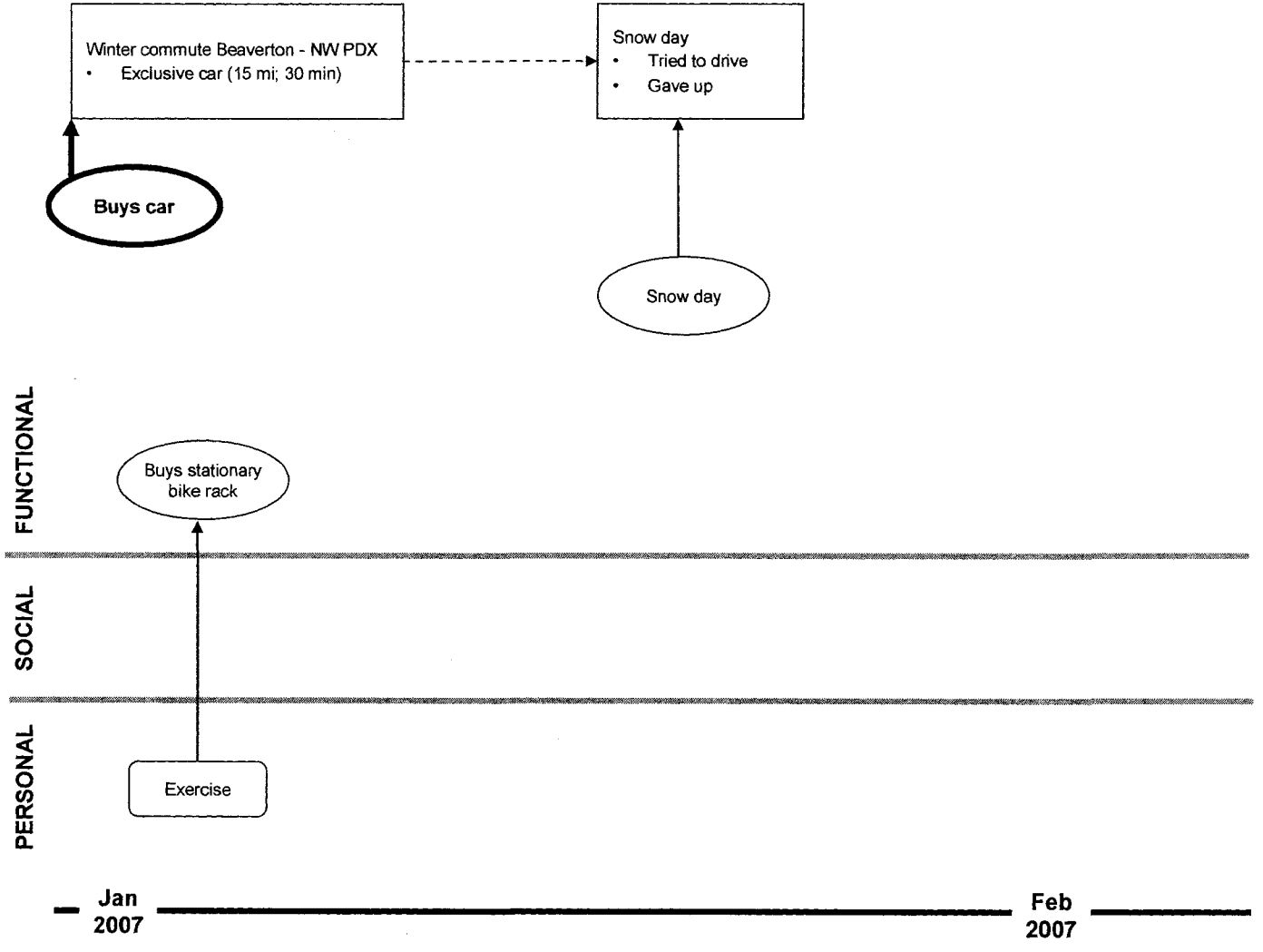
27/3


Commuting SW PDX - NW PDX
• Exclusive bike use (8 mi)
• Situational car with brother
Gets job in NW PDX
Falls
Flats
Learns maint skills
(+)
(-)
(-)
(-)
Bike tradeoff
Exercise
Safety
Time Utilization
Self-Confidence
Reliability
Flexibility
(-)
(+)
(+)
(-)
Refines routes
FUNCTIONAL
SOCIAL
PERSONAL
Seeks online information
Brother works downtown
Social isolation
Bridge Pedal
News reports
(-)
(-)
Online activism
Gas = Terror
Bike/car, Bike/ped conflict
Environmental awareness
Bike identity
Apr 2006
Summer 2006

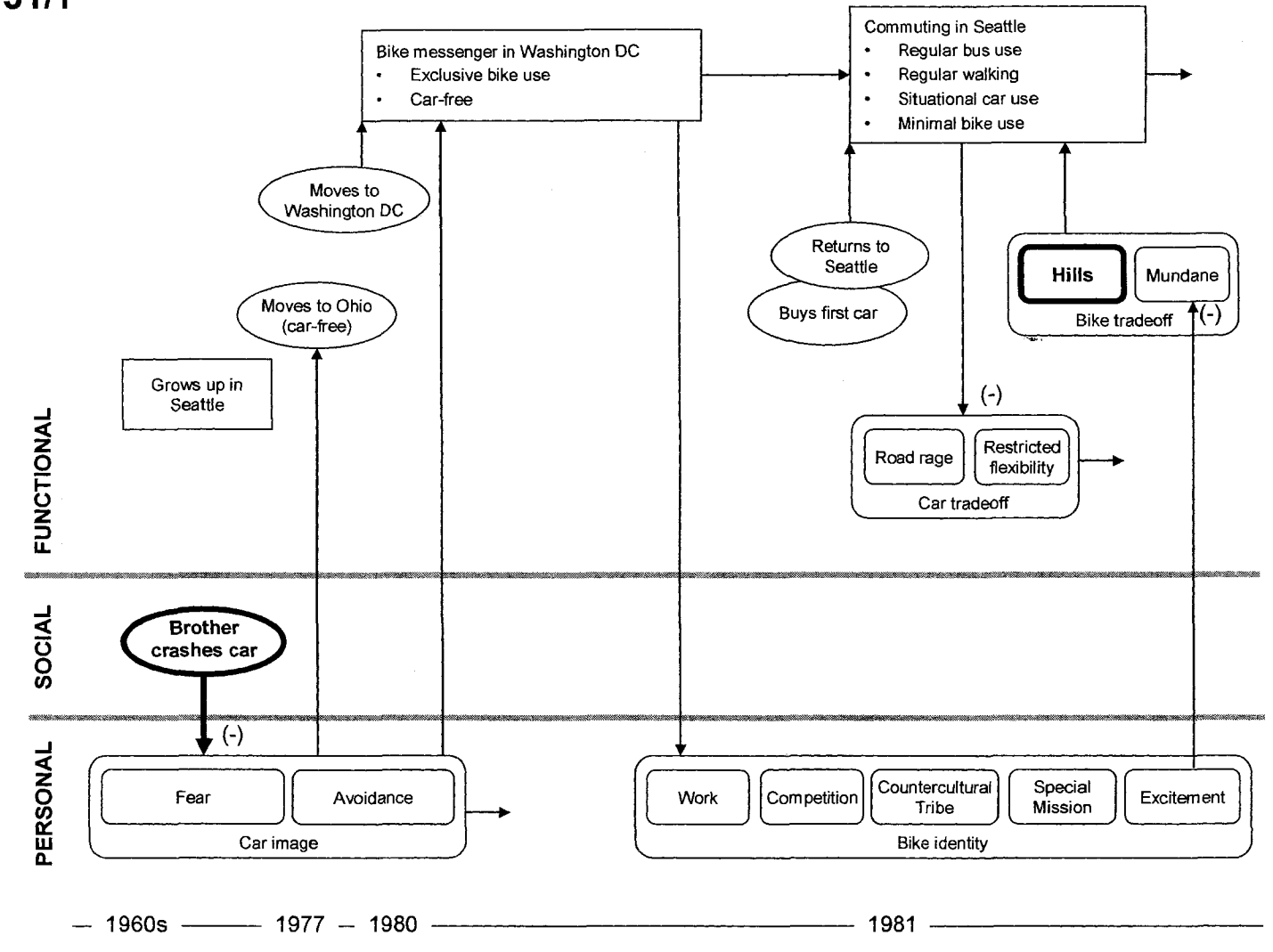

Commuting Beaverton - NW PDX
• Exclusive bike use (15 mi, 45 min)
Winter commute Beaverton - NW PDX
• Exclusive bike use (15 mi, 45 min)
Moves to Beaverton
Decides to bike through winter
Bike tradeoff
Safety
(-)
(+)
(-)
(-)
Rain
Cold
Safety
Personal challenge
Winter bike concerns
Beaverton not as bike-friendly
News reports of bike fatalities
Refines routes
FUNCTIONAL
SOCIAL
PERSONAL
Summer 2006
Aug 2006

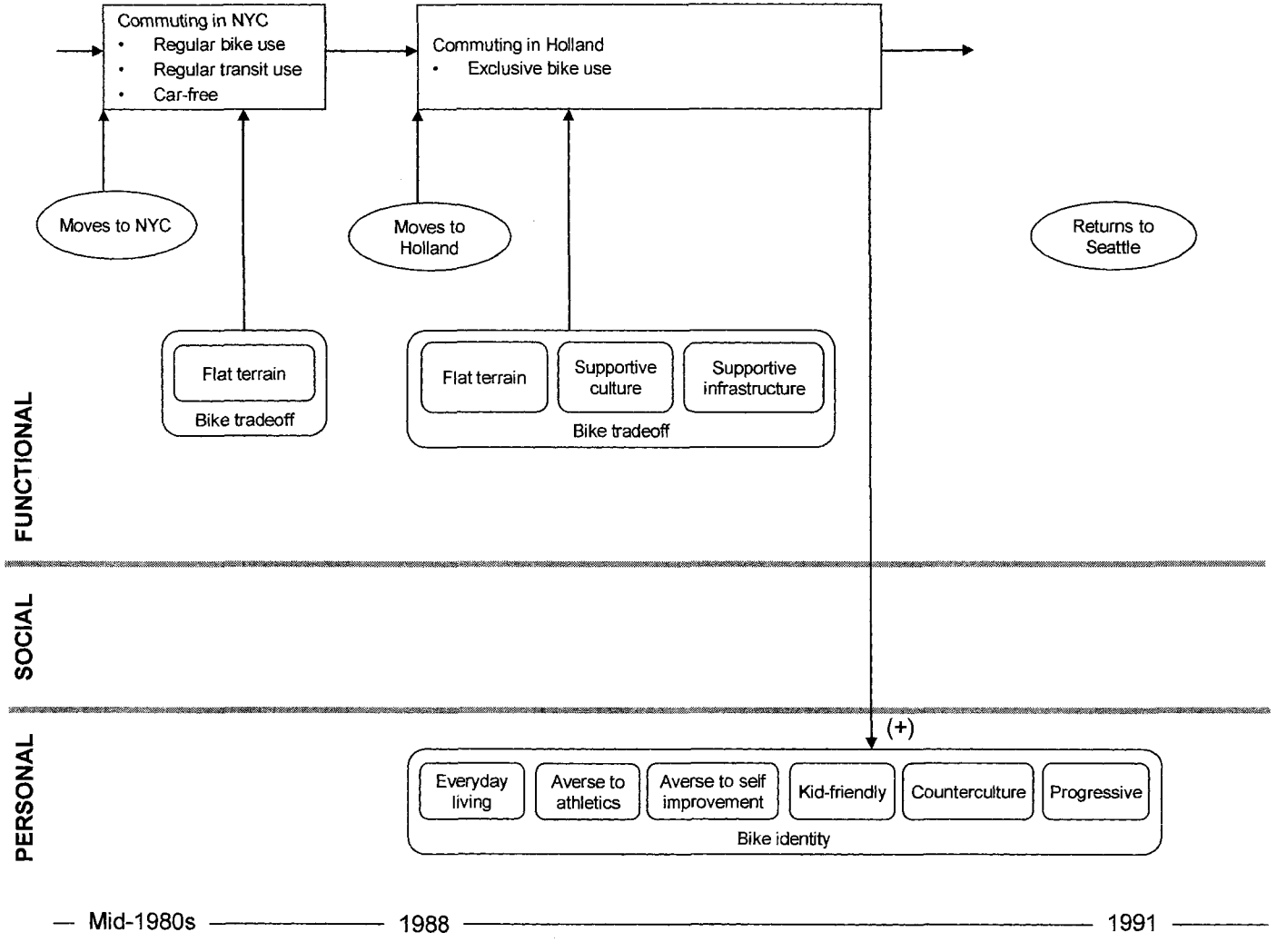

Winter commute Beaverton - NW PDX
• Exclusive bike use (15 mi, 45 min)
Discontinues biking
Rain + Cold
(+)
(--)
(--)
Safety
Exercise
Time Utilization
Fun
Temperature Regulation
Economical
Bike tradeoff
(-)
(-)
(+)
(--)
(--)
Hit by car
Buys light
Dark
Cold hands
Buys gloves
Seeks info online
FUNCTIONAL
SOCIAL
PERSONAL
Oct 2006
Nov 2006


Winter commute Beaverton - NW PDX
• Car pools with brother
Buys car
Discontinues biking
Decides to buy car
Color
Make
Mileage
Car finalist attributes
Car finalists
• Baby blue Ford
• VW Jetta
(-)
Car pool tradeoff
Economical
Easier Parking
Car pool tradeoff
Flexibility
Social Obligation
(-)
Purchase price
Gas mileage
Insurance
Car search attributes
FUNCTIONAL
SOCIAL
PERSONAL
Brother has schedule change
Seeks info from internet
Domestic make
"Girly" color
Self-image conflict
Nov 2006
Dec 2006

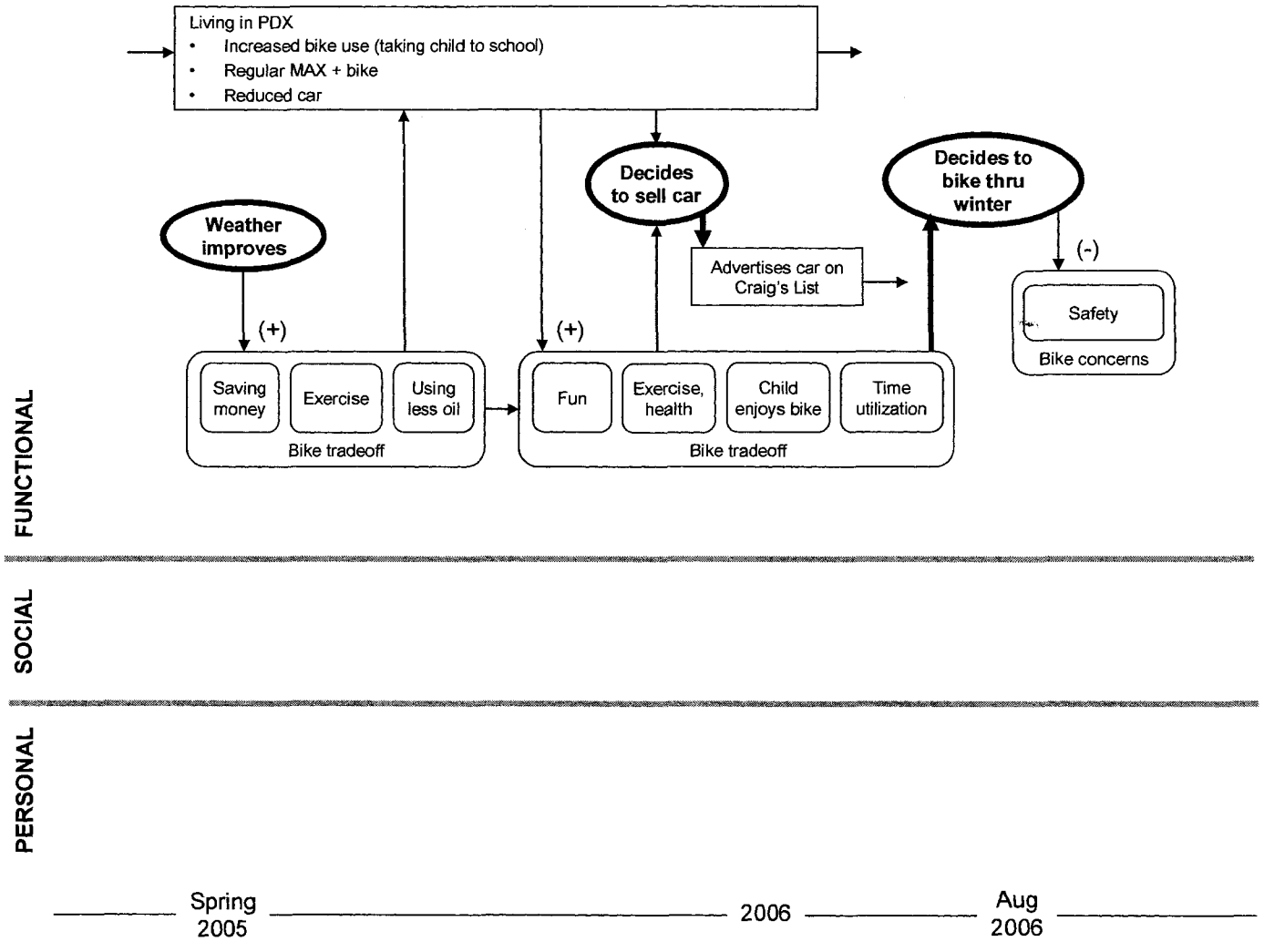

Winter commute Beaverton - NW PDX
• Exclusive car (15 mi; 30 min)
Snow day
• Tried to drive
• Gave up
Buys car
Snow day
FUNCTIONAL
SOCIAL
PERSONAL
Buys stationary bike rack
Exercise
Jan 2007
Feb 2007

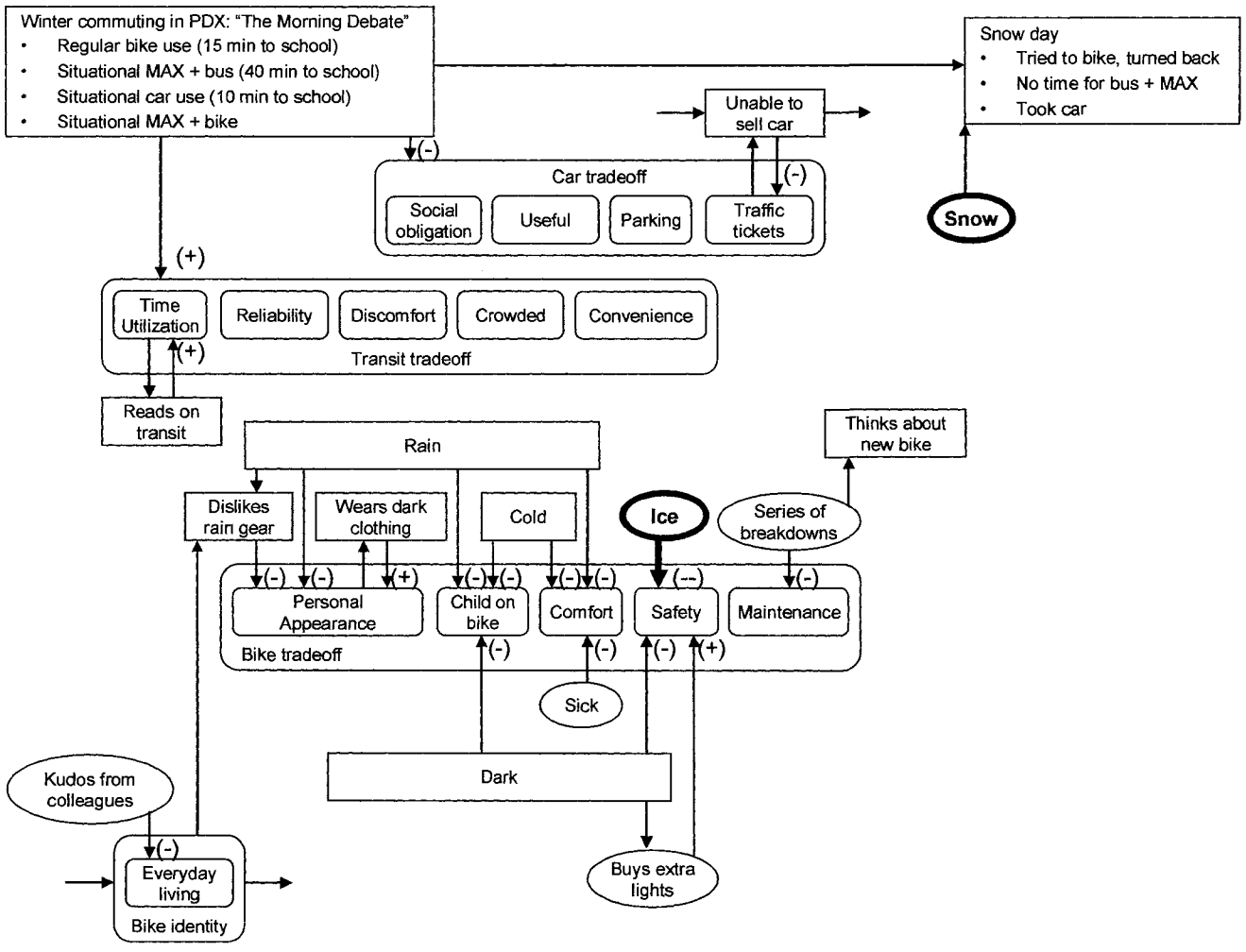
(458)


Bike messenger in Washington DC
• Exclusive bike use
• Car-free
Commuting in Seattle
• Regular bus use
• Regular walking
• Situational car use
• Minimal bike use
Moves to Washington DC
Returns to Seattle
Buys first car
Hills
Mundane
Bike tradeoff
(-)
Moves to Ohio (car-free)
Grows up in Seattle
(-)
Road rage
Restricted flexibility
Car tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
Brother crashes car
(-)
Fear
Avoidance
Car image
Work
Competition
Countercultural Tribe
Special Mission
Excitement
Bike identity
1960s
1977
1980
1981

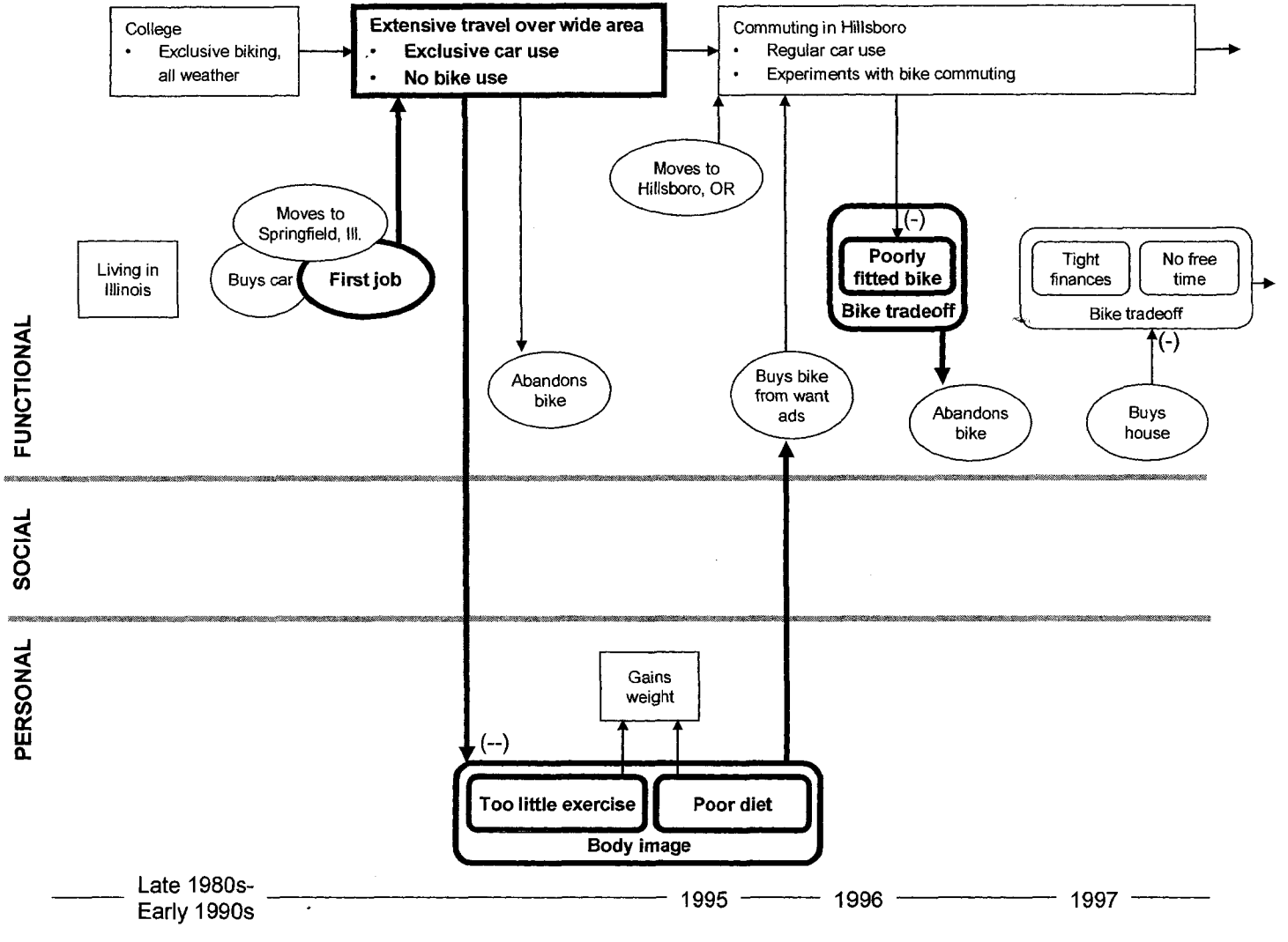

Commuting in NYC
• Regular bike use
• Regular transit use
• Car-free
Commuting in Holland
• Exclusive bike use
Moves to NYC
Moves to Holland
Returns to Seattle
Flat terrain
Bike tradeoff
Flat terrain
Supportive culture
Supportive infrastructure
Bike tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
(+)
Everyday living
Averse to athletics
Averse to self improvement
Kid-friendly
Counterculture
Progressive
Bike identity
Mid-1980s
1988
1991

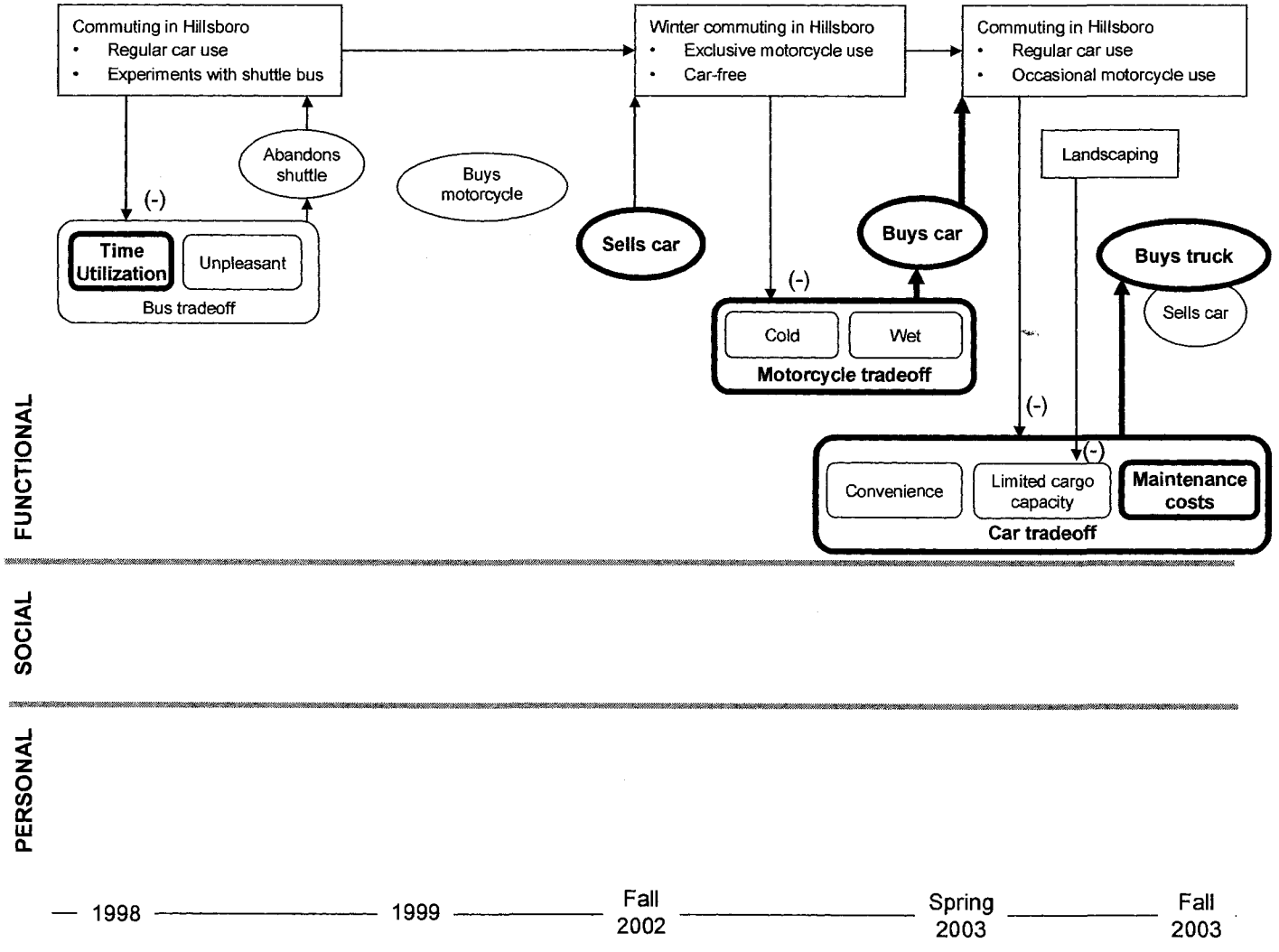
PERSONAL
SOCIAL
FUNCTIONAL
Child born
Child care
(-)
Expensive
Road rage
Car tradeoff
Moves to PDX
Living in PDX
Regular car use
Occasional transit use
Greatly reduced bike use
MAX Yellow Line opens
Living in PDX
Car use decreasing
MAX use increasing
(+)
Availability
Accessibility
Time Utilization
Transit tradeoff
(+)
Reads on transit
Hears about Flexcar
Insurance Problems
Does not subscribe
1999
2000
2004

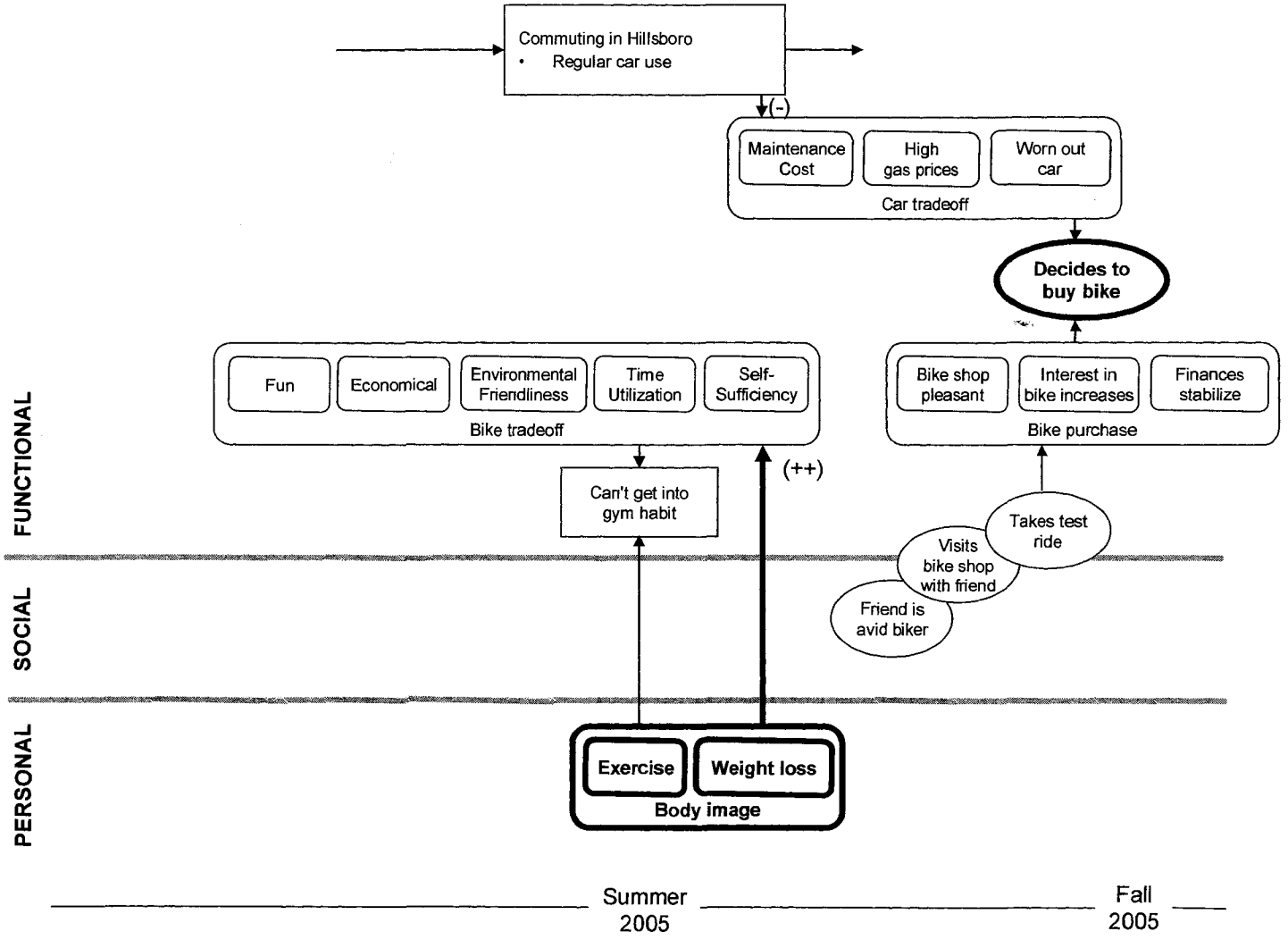

Living in PDX
• Increased bike use (taking child to school)
• Regular MAX + bike
• Reduced car
Weather improves
(+)
Saving money
Exercise
Using less oil
Bike tradeoff
Decides to sell car
(+)
Advertises car on Craig's List
Fun
Exercise, health
Child enjoys bike
Time utilization
Bike tradeoff
Decides to bike thru winter
(-)
Safety
Bike concerns
FUNCTIONAL
SOCIAL
PERSONAL
Spring 2005
2006
Aug 2006

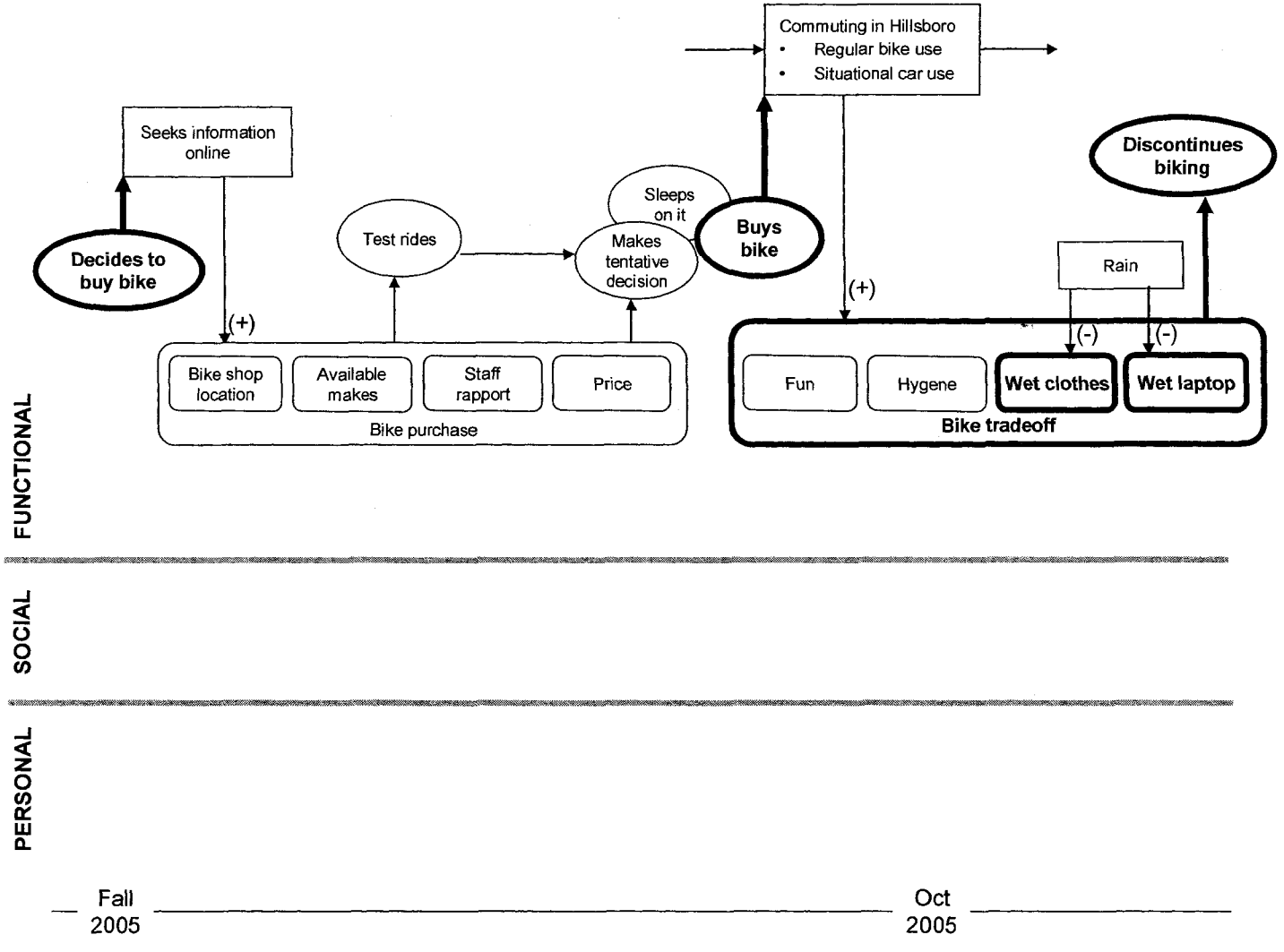

Winter commuting in PDX: "The Morning Debate"
• Regular bike use (15 min to school)
• Situational MAX + bus (40 min to school)
• Situational car use (10 min to school)
• Situational MAX + bike
Snow day
• Tried to bike, turned back
• No time for bus + MAX
• Took car
Unable to sell car
Car tradeoff
Social obligation
Useful
Parking
Traffic tickets
Snow
Time Utilization
Reliability
Discomfort
Crowded
Convenience
Transit tradeoff
Reads on transit
Rain
Thinks about new bike
Dislikes rain gear
Wears dark clothing
Cold
Ice
Series of breakdowns
Personal Appearance
Child on bike
Comfort
Safety
Maintenance
Bike tradeoff
Sick
Dark
Kudos from colleagues
Everyday living
Bike identity
Buys extra lights

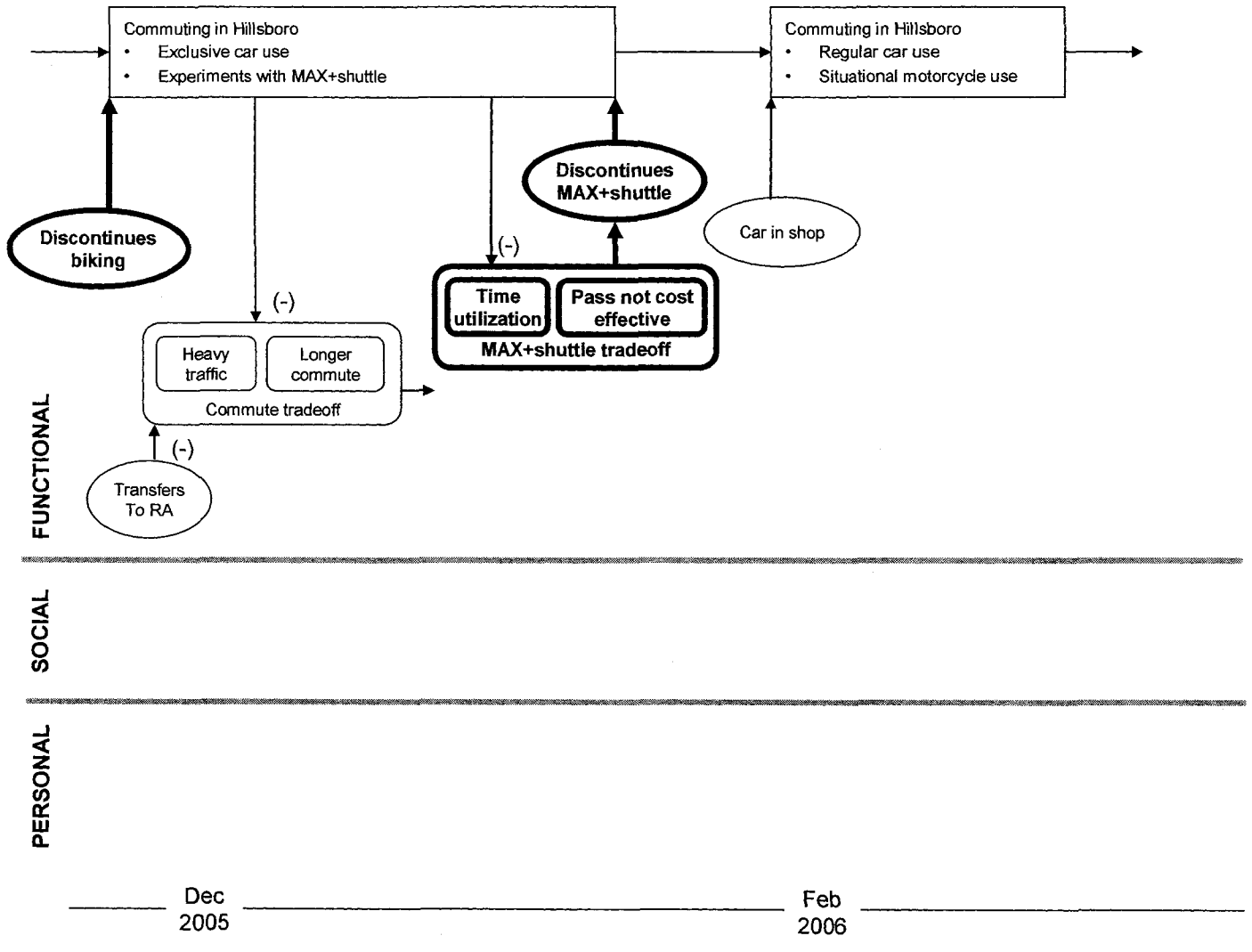
33/1

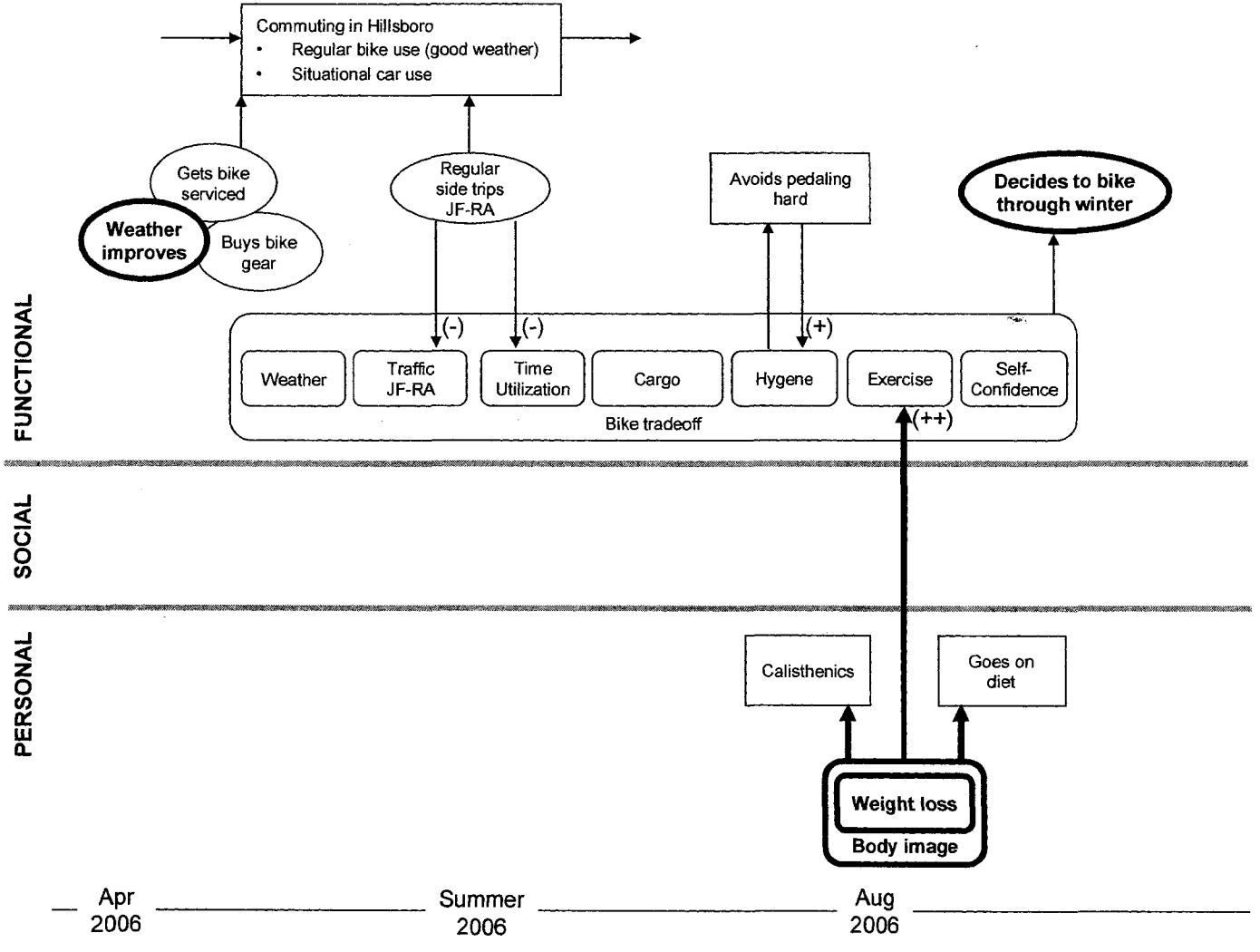

College
• Exclusive biking, all weather
Extensive travel over wide area
• Exclusive car use
• No bike use
Commuting in Hillsboro
• Regular car use
• Experiments with bike commuting
Moves to Hillsboro, OR
Moves to Springfield, Ill.
Living in Illinois
Buys car
First job
Abandons bike
(-)
Poorly fitted bike
Bike tradeoff
Tight finances
No free time
Bike tradeoff
(-)
Buys bike from want ads
Abandons bike
Buys house
FUNCTIONAL
SOCIAL
PERSONAL
Gains weight
(--)
Too little exercise
Poor diet
Body image
Late 1980s-Early 1990s
1995
1996
1997

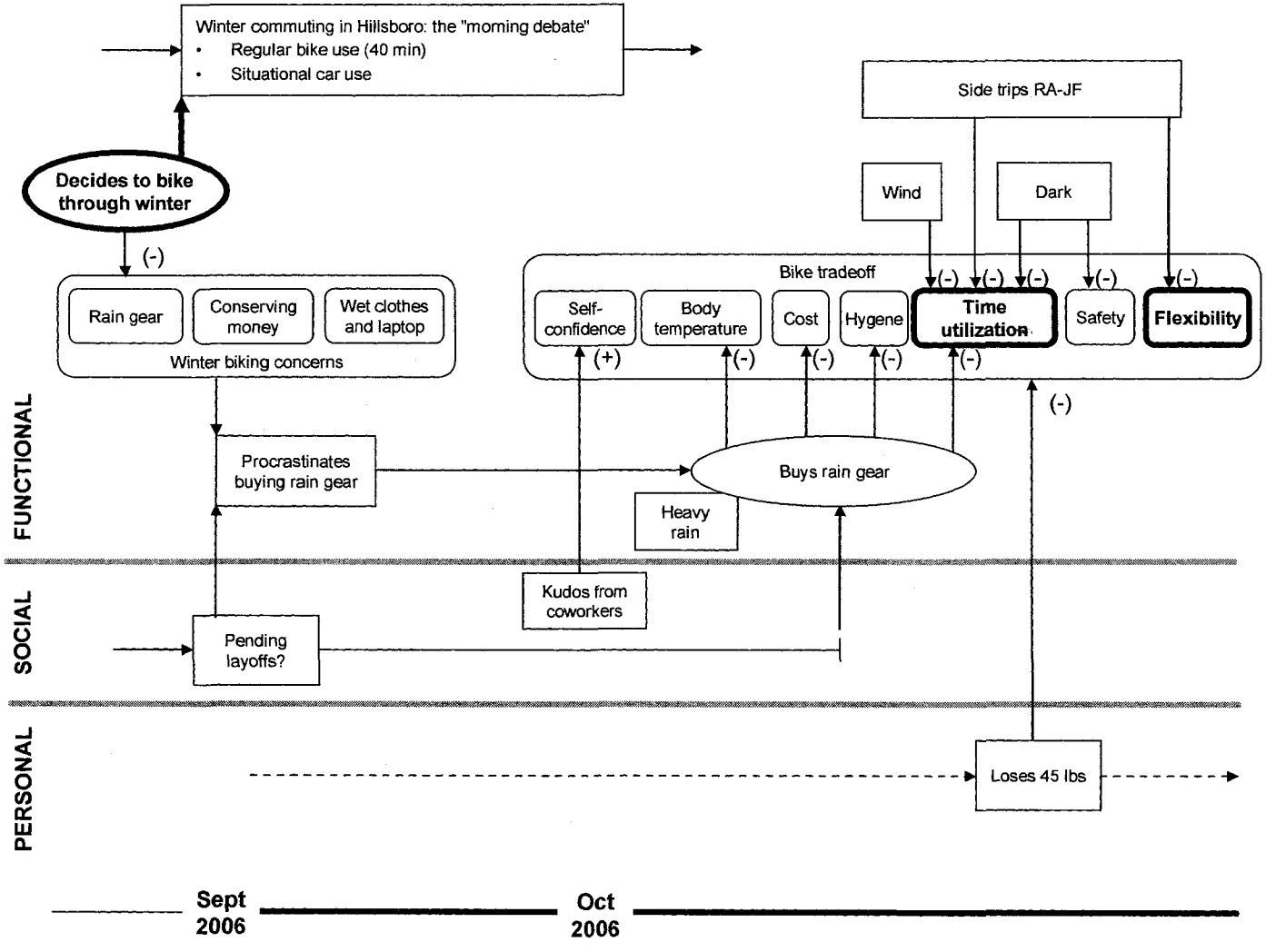

Commuting in Hillsboro
• Regular car use
• Experiments with shuttle bus
Winter commuting in Hillsboro
• Exclusive motorcycle use
• Car-free
Commuting in Hillsboro
• Regular car use
• Occasional motorcycle use
Abandons shuttle
Buys motorcycle
Landscaping
(-)
Time Utilization
Unpleasant
Bus tradeoff
Sells car
Buys car
Buys truck
Sells car
(-)
Cold
Wet
Motorcycle tradeoff
(-)
(-)
Convenience
Limited cargo capacity
Maintenance costs
Car tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
1998
1999
Fall 2002
Spring 2003
Fall 2003


Commuting in Hillsboro
• Regular car use
(-)
Maintenance Cost
High gas prices
Worn out car
Car tradeoff
Decides to buy bike
Fun
Economical
Environmental Friendliness
Time Utilization
Self-Sufficiency
Bike tradeoff
Bike shop pleasant
Interest in bike increases
Finances stabilize
Bike purchase
(++)
Can't get into gym habit
Takes test ride
Visits bike shop with friend
Friend is avid biker
FUNCTIONAL
SOCIAL
PERSONAL
Exercise
Weight loss
Body image
Summer 2005
Fall 2005

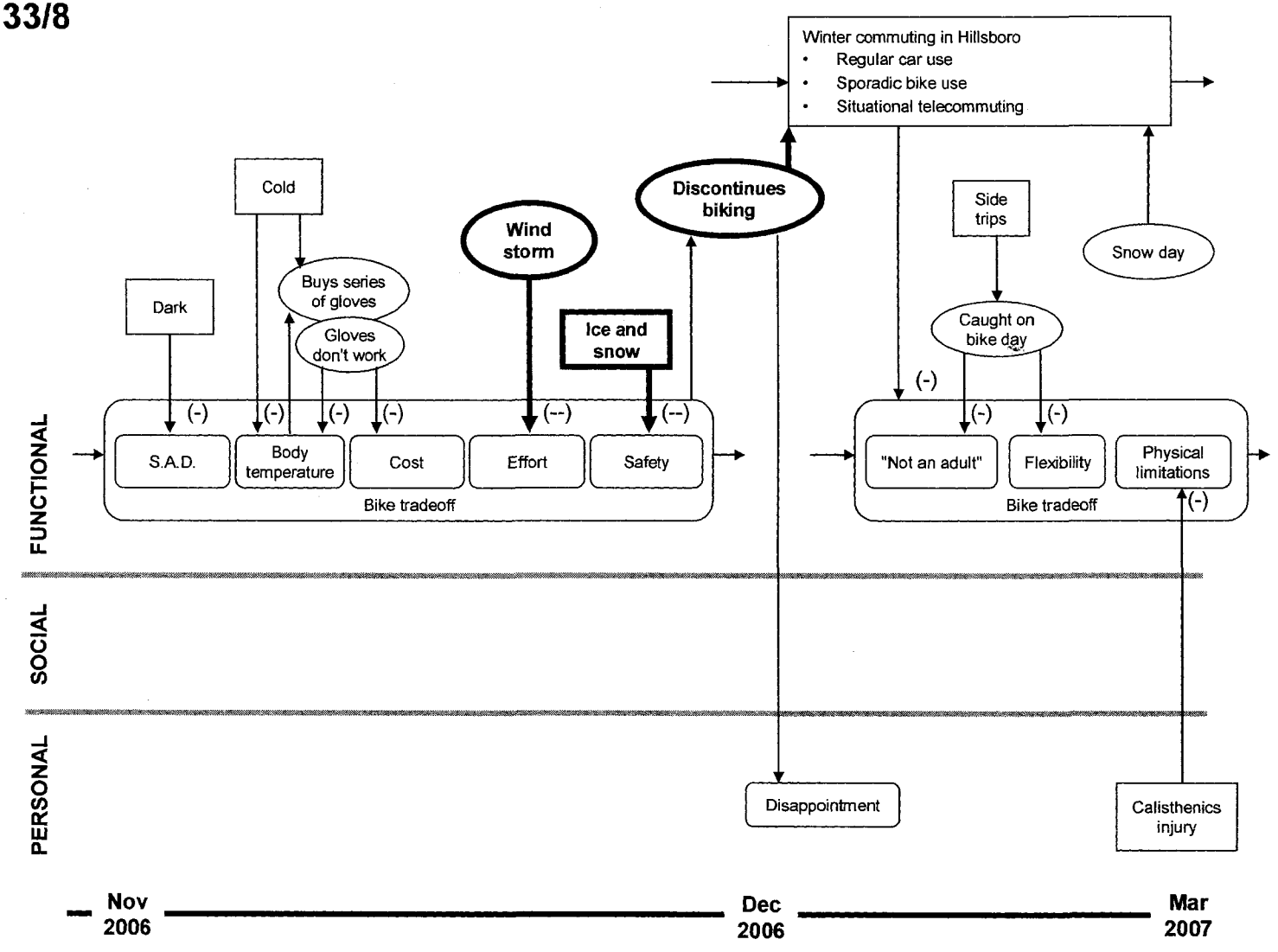

Commuting in Hillsboro
• Regular bike use
• Situational car use
Seeks information online
Decides to buy bike
(+)
Test rides
Sleeps on it
Makes tentative decision
Buys bike
Discontinues biking
Rain
(+)
(-)
(-)
Bike shop location
Available makes
Staff rapport
Price
Bike purchase
Fun
Hygene
Wet clothes
Wet laptop
Bike tradeoff
FUNCTIONAL
SOCIAL
PERSONAL
Fall 2005
Oct 2005

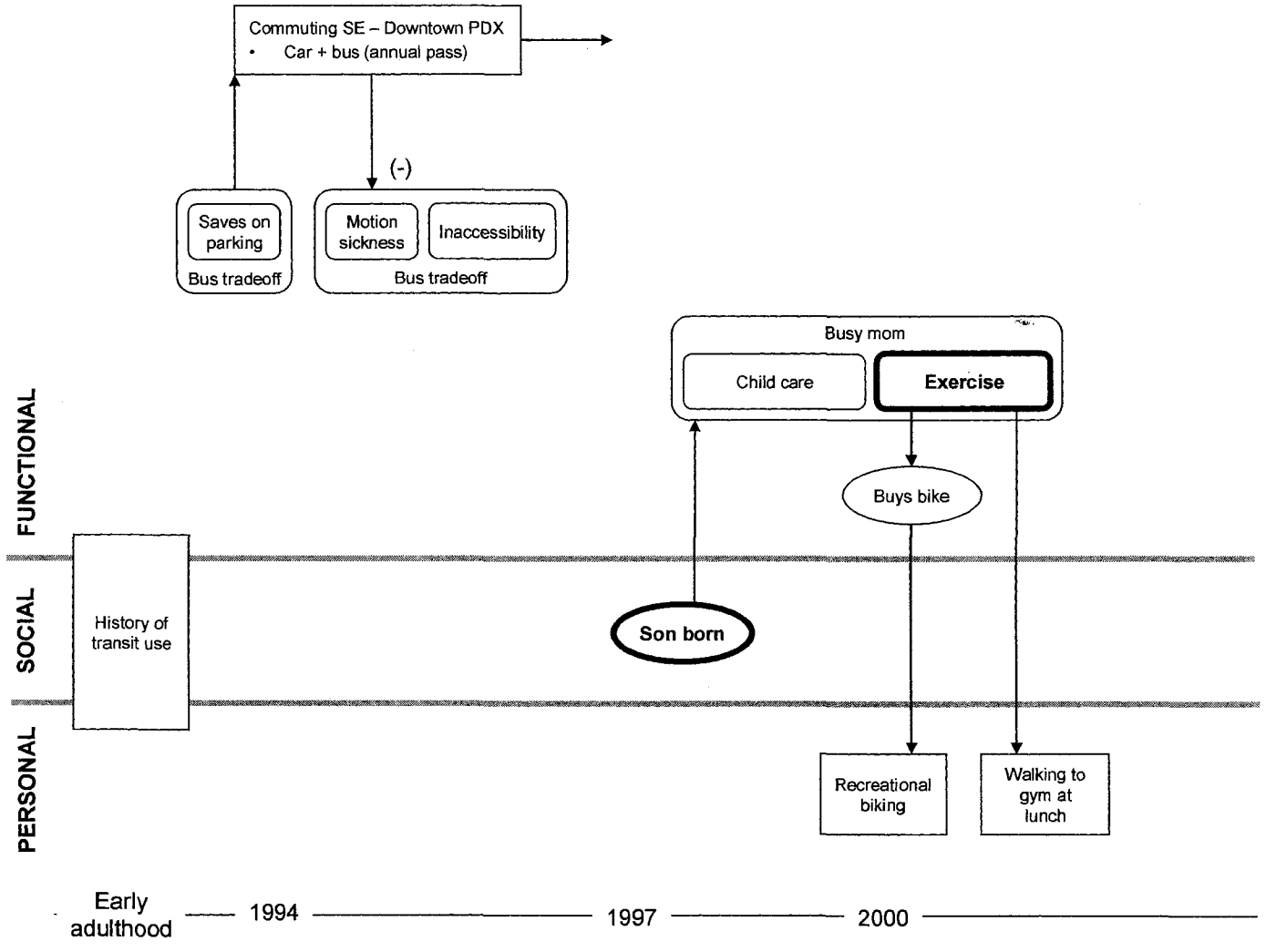

Commuting in Hillsboro
• Exclusive car use
• Experiments with MAX+shuttle
Commuting in Hillsboro
• Regular car use
• Situational motorcycle use
Discontinues biking
Discontinues MAX+shuttle
Car in shop
(-)
Time utilization
Pass not cost effective
MAX+shuttle tradeoff
(-)
Heavy traffic
Longer commute
Commute tradeoff
(-)
Transfers To RA
FUNCTIONAL
SOCIAL
PERSONAL
Dec 2005
Feb 2006


Commuting in Hillsboro
• Regular bike use (good weather)
• Situational car use
Gets bike serviced
Weather improves
Buys bike gear
Regular side trips JF-RA
Avoids pedaling hard
Decides to bike through winter
(-)
(-)
(+)
Weather
Traffic JF-RA
Time Utilization
Cargo
Hygene
Exercise
Self-Confidence
Bike tradeoff
(++)
FUNCTIONAL
SOCIAL
PERSONAL
Calisthenics
Goes on diet
Weight loss
Body image
Apr 2006
Summer 2006
Aug 2006

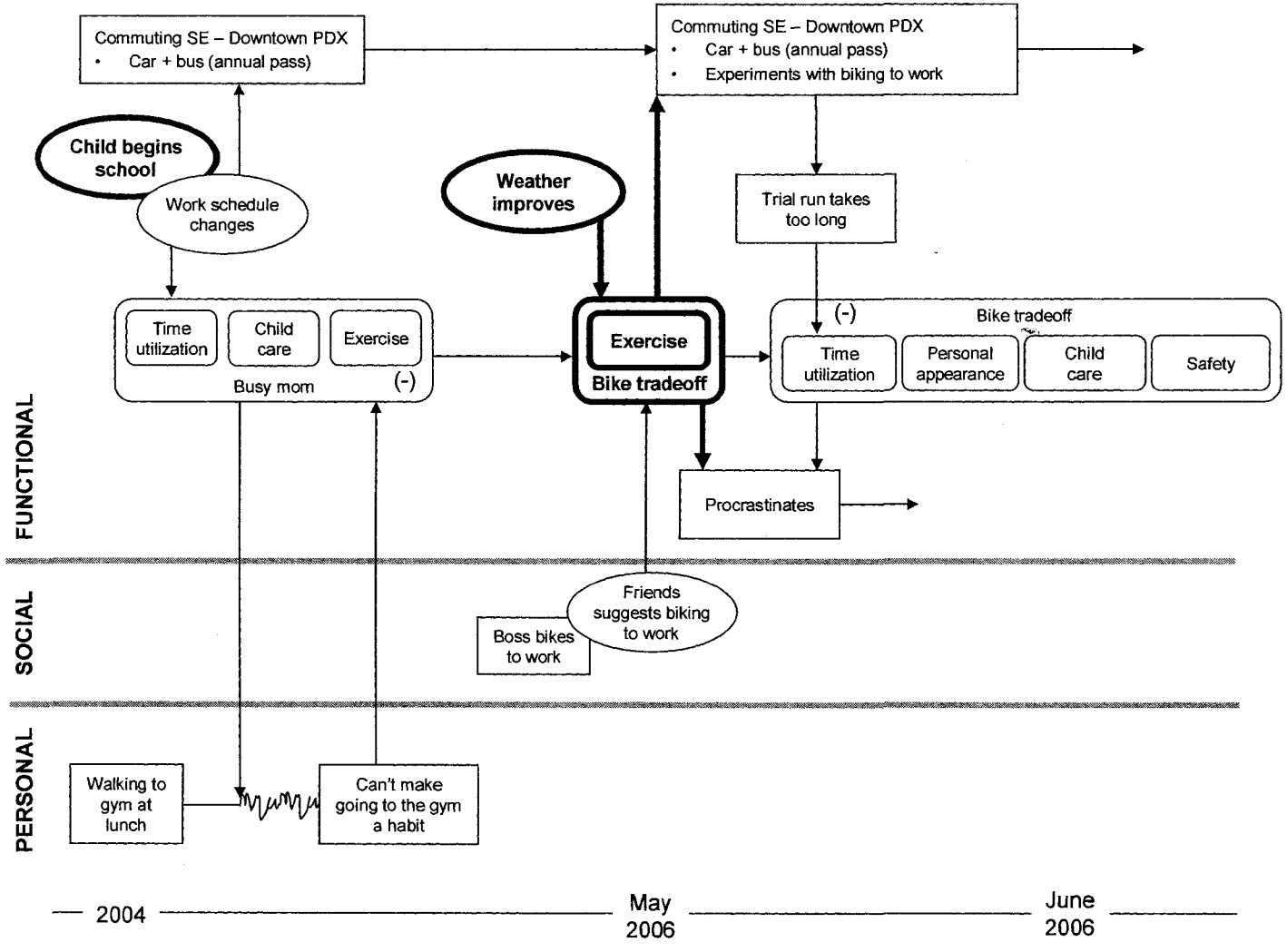

Winter commuting in Hillsboro: the "morning debate"
• Regular bike use (40 min)
• Situational car use
Side trips RA-JF
Wind
Dark
Decides to bike through winter
(-)
Bike tradeoff
Rain gear
Conserving money
Wet clothes and laptop
Winter biking concerns
Self-confidence
Body temperature
Cost
Hygene
Time utilization
Safety
Flexibility
(+)
(-)
FUNCTIONAL
Procrastinates buying rain gear
Buys rain gear
Heavy rain
SOCIAL
Kudos from coworkers
Pending layoffs?
PERSONAL
Loses 45 lbs
Sept 2006
Oct 2006

(470)

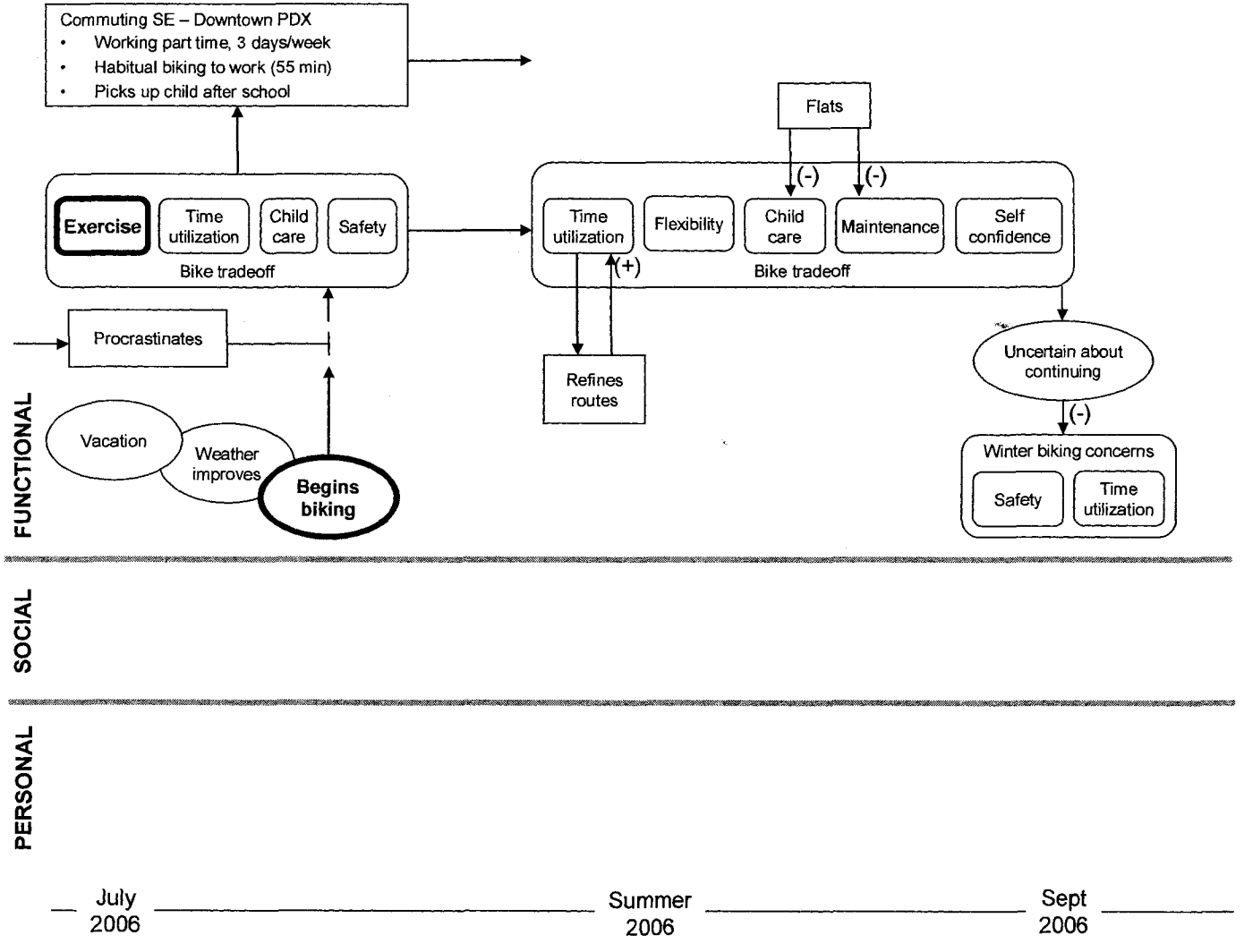

Winter commuting in Hillsboro
• Regular car use
• Sporadic bike use
• Situational telecommuting
Cold
Dark
Buys series of gloves
Gloves don't work
Wind storm
Ice and snow
Discontinues biking
Side trips
Snow day
Caught on bike day
(-)
(-)
(-)
(-)
(-)
(--)
(--)
(-)
(-)
(-)
S.A.D.
Body temperature
Cost
Effort
Safety
Bike tradeoff
"Not an adult"
Flexibility
Physical limitations
Bike tradeoff
(-)
FUNCTIONAL
SOCIAL
PERSONAL
Disappointment
Calisthenics injury
Nov 2006
Dec 2006
Mar 2007


Commuting SE – Downtown PDX
• Car + bus (annual pass)
(-)
Saves on parking
Bus tradeoff
Motion sickness
Inaccessibility
Bus tradeoff
Busy mom
Child care
Exercise
Buys bike
FUNCTIONAL
SOCIAL
PERSONAL
History of transit use
Son born
Recreational biking
Walking to gym at lunch
Early adulthood
1994
1997
2000

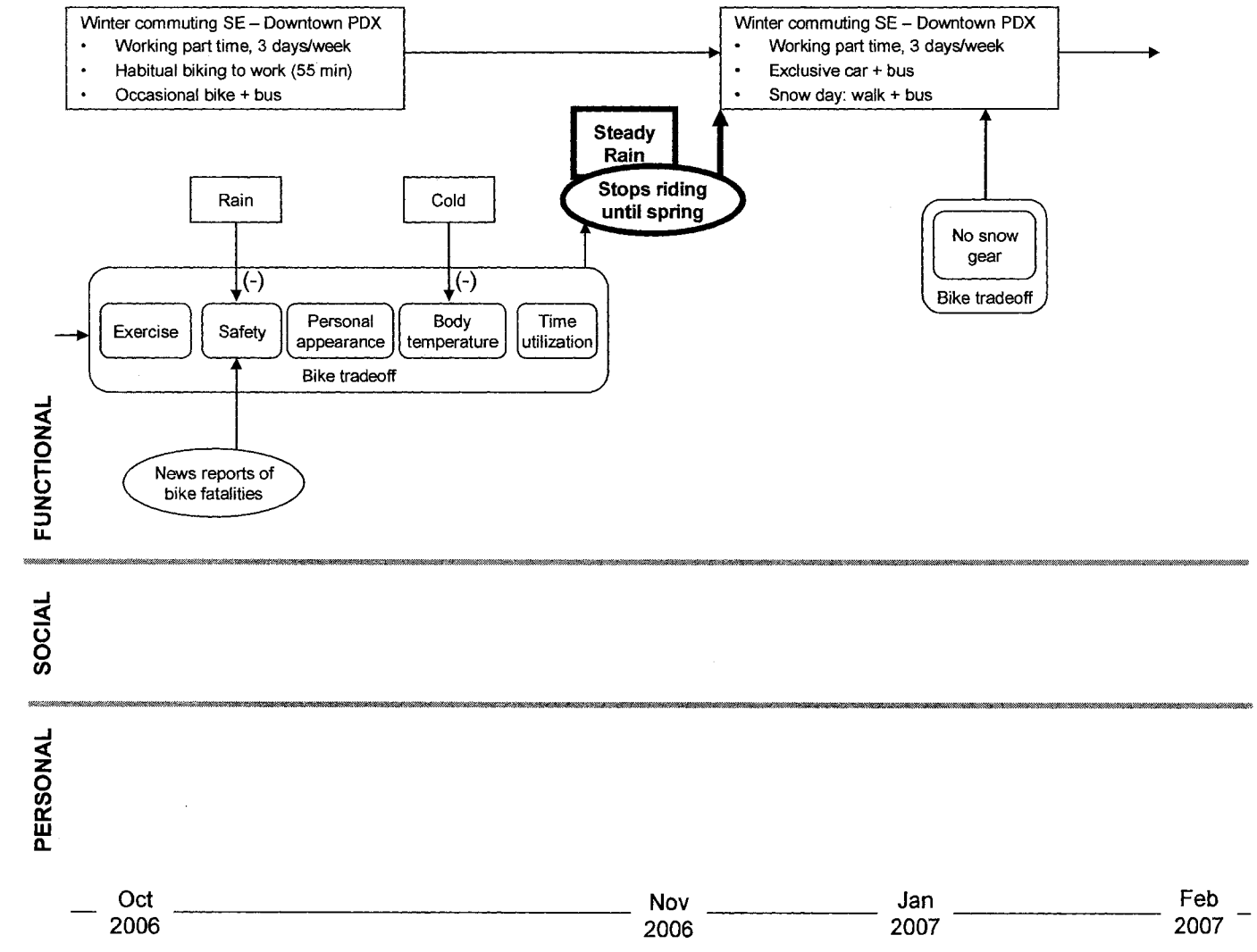
36/2

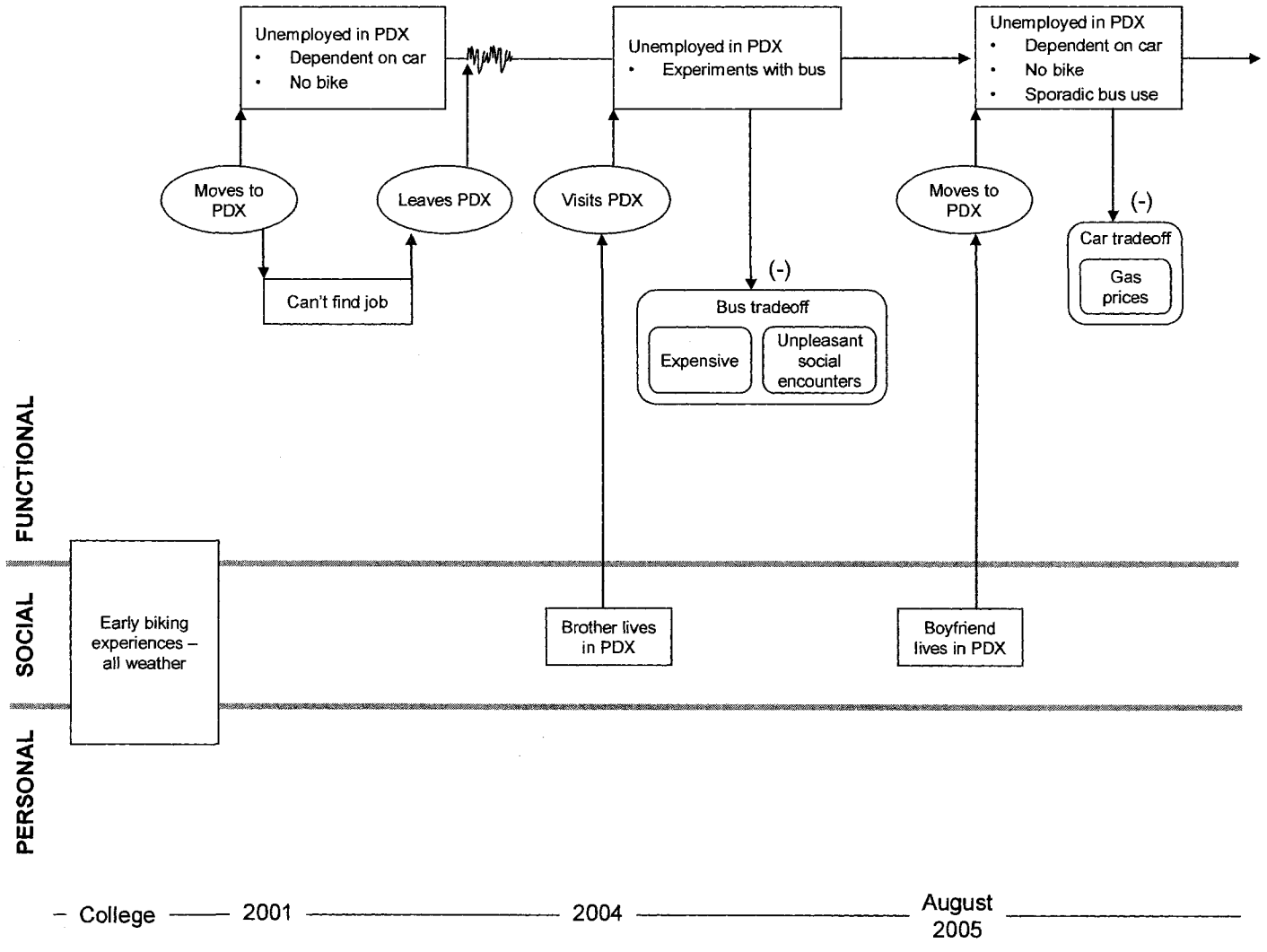

Commuting SE – Downtown PDX
• Car + bus (annual pass)
Commuting SE – Downtown PDX
• Car + bus (annual pass)
• Experiments with biking to work
Child begins school
Work schedule changes
Weather improves
Trial run takes too long
Time utilization
Child care
Exercise
Busy mom
(-)
Exercise
Bike tradeoff
(-)
Bike tradeoff
Time utilization
Personal appearance
Child care
Safety
Procrastinates
FUNCTIONAL
SOCIAL
PERSONAL
Friends suggests biking to work
Boss bikes to work
Walking to gym at lunch
Can't make going to the gym a habit
2004
May 2006
June 2006

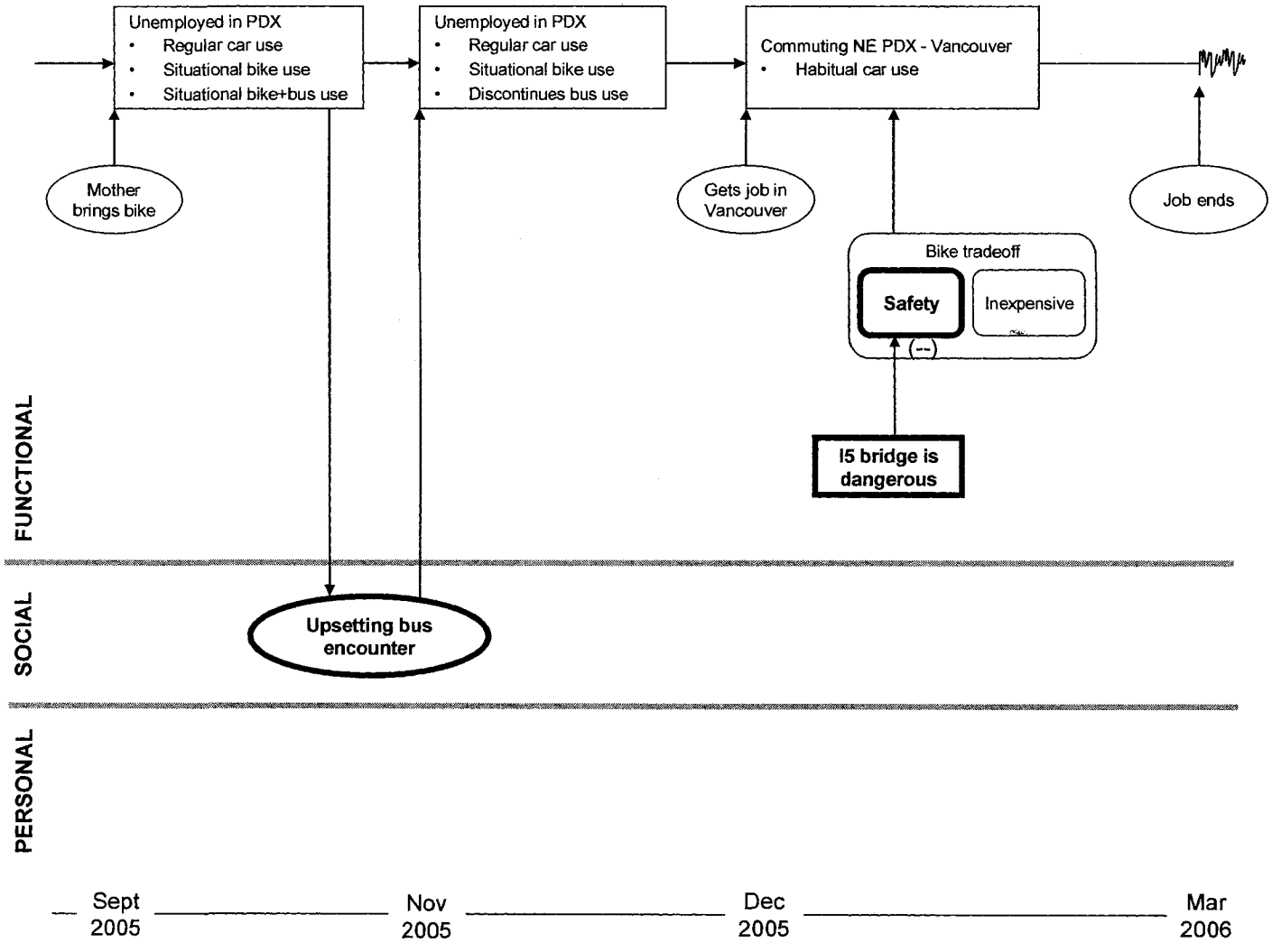
36/3

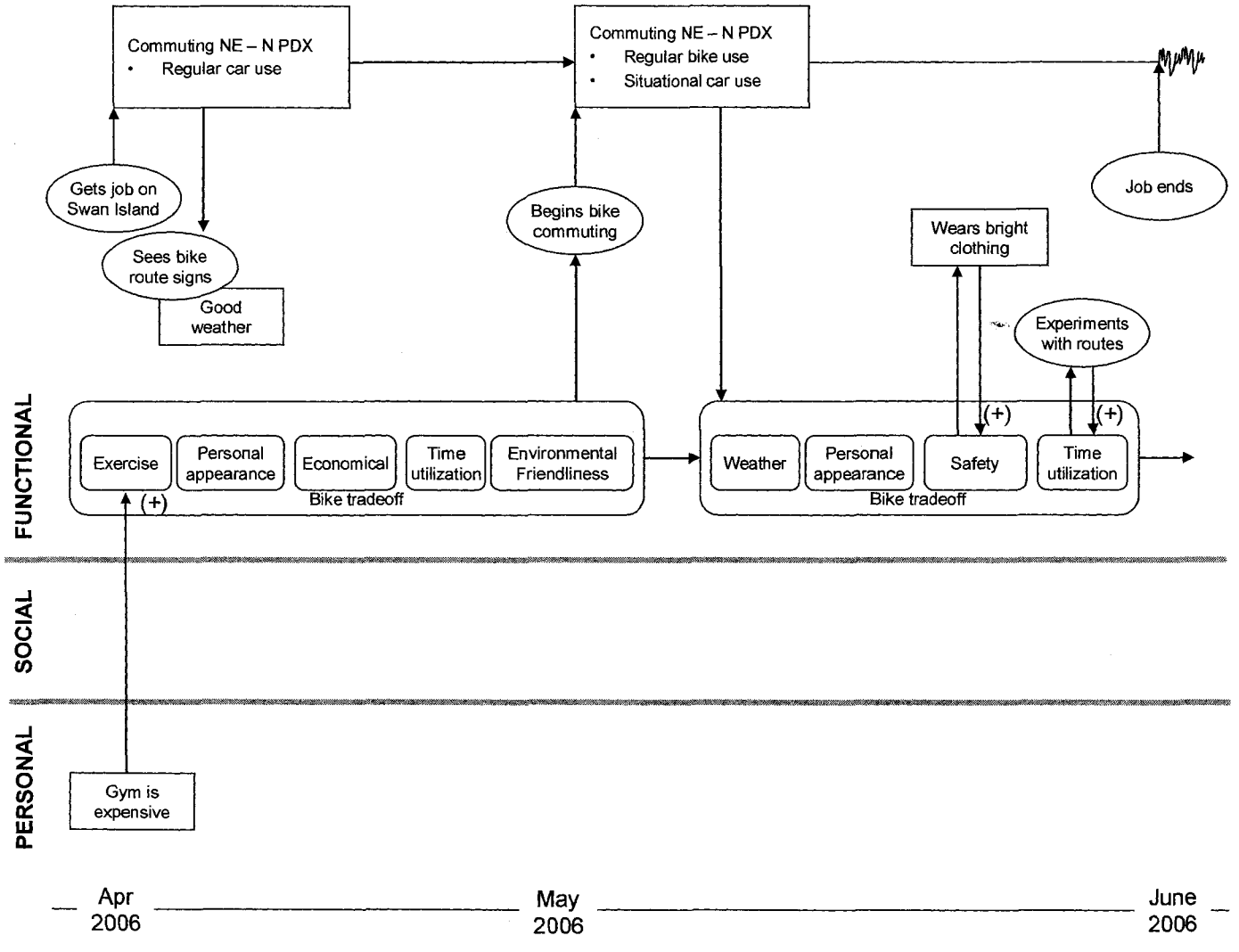

Commuting SE – Downtown PDX
• Working part time, 3 days/week
• Habitual biking to work (55 min)
• Picks up child after school
Exercise
Time utilization
Child care
Safety
Bike tradeoff
Procrastinates
Vacation
Weather improves
Begins biking
Flats
(-)
(-)
Time utilization
Flexibility
Child care
Maintenance
Self confidence
Bike tradeoff
(+)
Refines routes
Uncertain about continuing
(-)
Winter biking concerns
Safety
Time utilization
FUNCTIONAL
SOCIAL
PERSONAL
July 2006
Summer 2006
Sept 2006

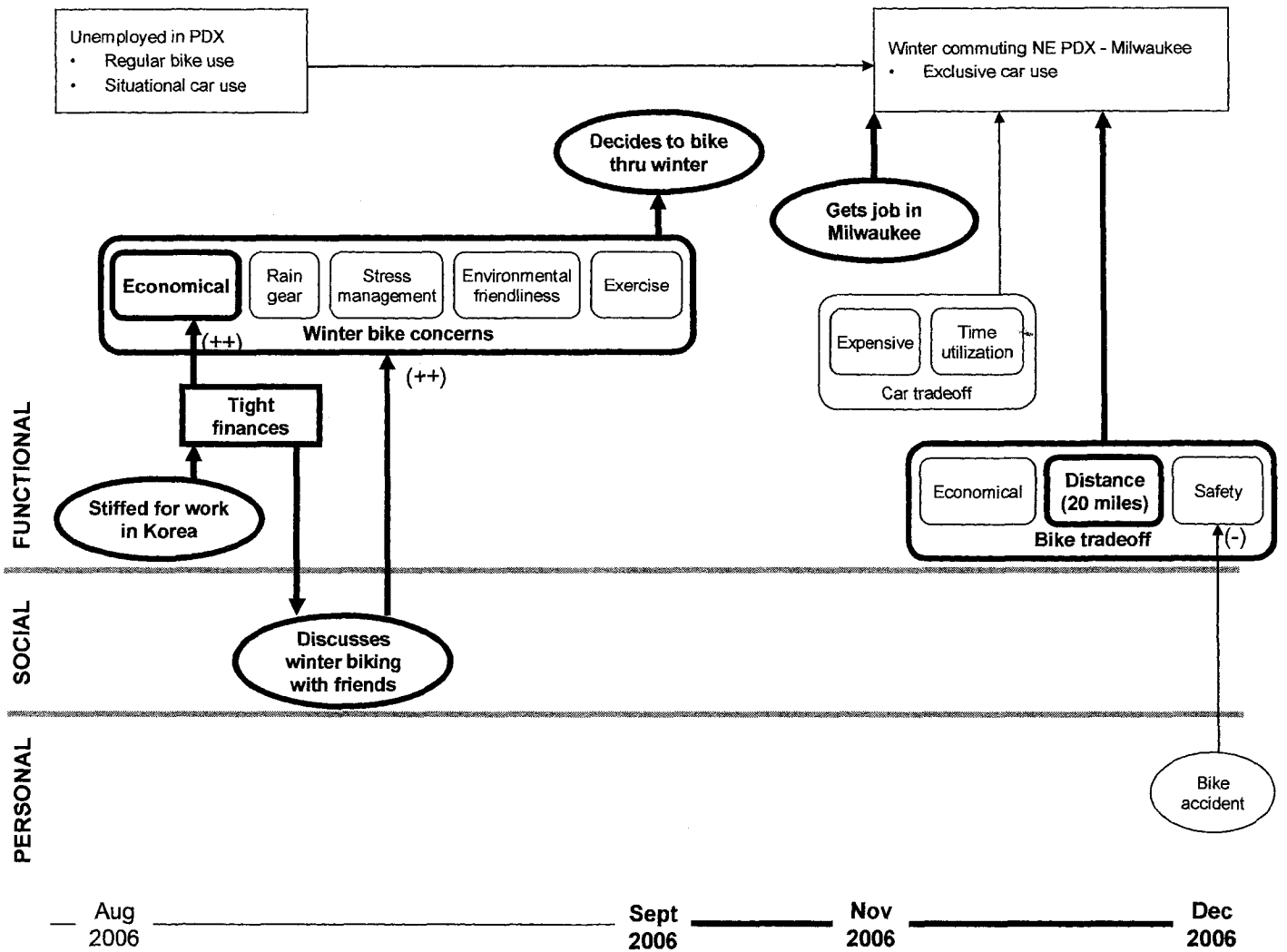
36/4

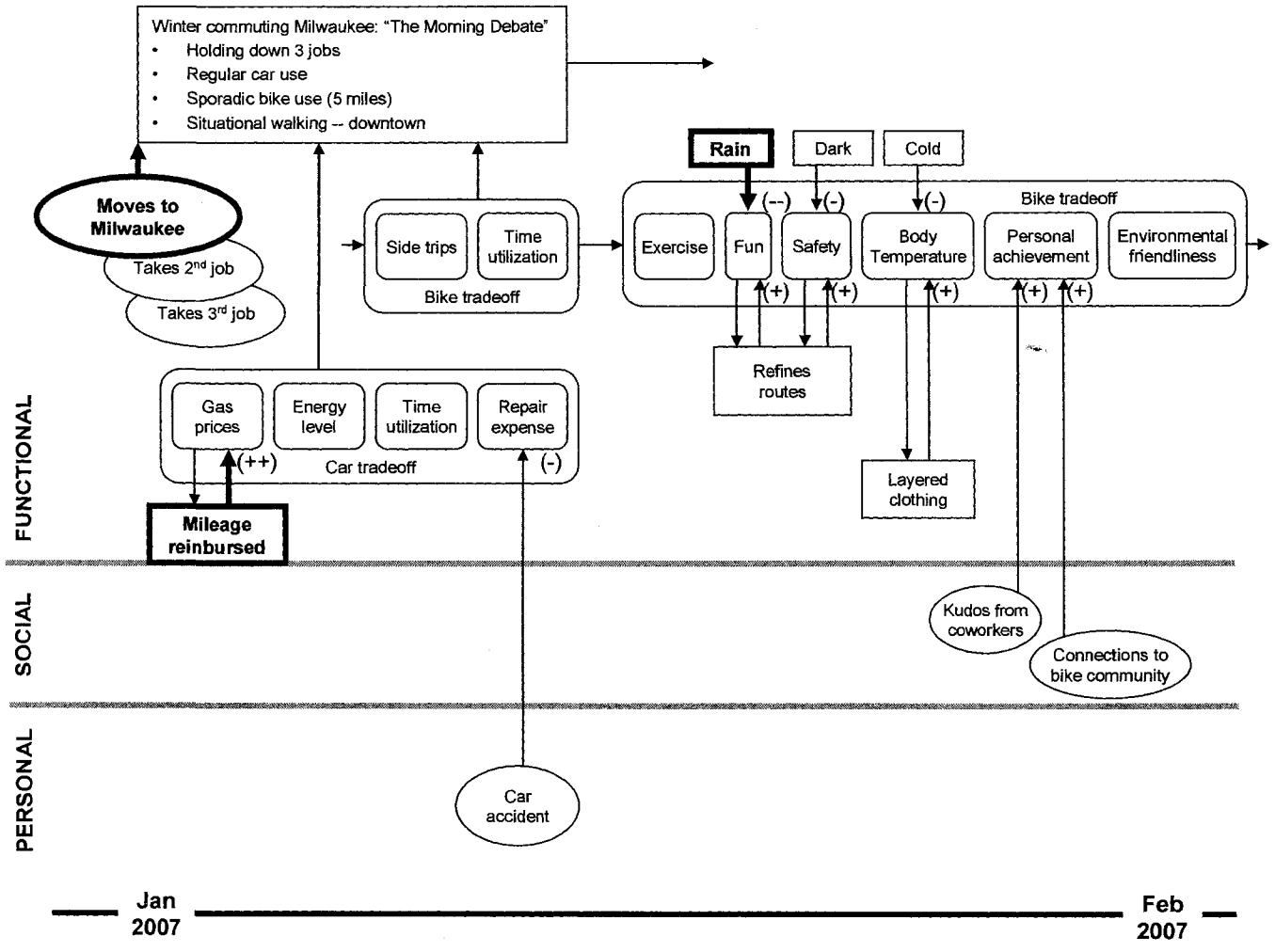

Winter commuting SE – Downtown PDX
• Working part time, 3 days/week
• Habitual biking to work (55 min)
• Occasional bike + bus
Winter commuting SE – Downtown PDX
• Working part time, 3 days/week
• Exclusive car + bus
• Snow day: walk + bus
Steady Rain
Stops riding until spring
Rain
Cold
(-)
(-)
Exercise
Safety
Personal appearance
Body temperature
Time utilization
Bike tradeoff
No snow gear
Bike tradeoff
News reports of bike fatalities
FUNCTIONAL
SOCIAL
PERSONAL
Oct 2006
Nov 2006
Jan 2007
Feb 2007


Unemployed in PDX
• Dependent on car
• No bike
Unemployed in PDX
• Experiments with bus
Unemployed in PDX
• Dependent on car
• No bike
• Sporadic bus use
Moves to PDX
Leaves PDX
Visits PDX
Moves to PDX
(-)
Car tradeoff
Gas prices
Can't find job
(-)
Bus tradeoff
Expensive
Unpleasant social encounters
FUNCTIONAL
SOCIAL
PERSONAL
Early biking experiences – all weather
Brother lives in PDX
Boyfriend lives in PDX
College
2001
2004
August 2005


Unemployed in PDX
• Regular car use
• Situational bike use
• Situational bike+bus use
Unemployed in PDX
• Regular car use
• Situational bike use
• Discontinues bus use
Commuting NE PDX - Vancouver
• Habitual car use
Mother brings bike
Gets job in Vancouver
Job ends
Bike tradeoff
Safety
Inexpensive
(--)
I5 bridge is dangerous
FUNCTIONAL
SOCIAL
PERSONAL
Upsetting bus encounter
Sept 2005
Nov 2005
Dec 2005
Mar 2006


Commuting NE – N PDX
• Regular car use
Commuting NE – N PDX
• Regular bike use
• Situational car use
Gets job on Swan Island
Sees bike route signs
Good weather
Begins bike commuting
Wears bright clothing
Job ends
Experiments with routes
(+)
(+)
FUNCTIONAL
Exercise
Personal appearance
Economical
Time utilization
Environmental Friendliness
Bike tradeoff
(+)
Weather
Personal appearance
Safety
Time utilization
Bike tradeoff
SOCIAL
PERSONAL
Gym is expensive
Apr 2006
May 2006
June 2006


Unemployed in PDX
• Regular bike use
• Situational car use
Winter commuting NE PDX - Milwaukee
• Exclusive car use
Decides to bike thru winter
Gets job in Milwaukee
Economical
Rain gear
Stress management
Environmental friendliness
Exercise
Winter bike concerns
(++)
(++)
Expensive
Time utilization
Car tradeoff
Tight finances
Stiffed for work in Korea
Economical
Distance (20 miles)
Safety
Bike tradeoff
(-)
FUNCTIONAL
SOCIAL
PERSONAL
Discusses winter biking with friends
Bike accident
Aug 2006
Sept 2006
Nov 2006
Dec 2006


Winter commuting Milwaukee: "The Morning Debate"
• Holding down 3 jobs
• Regular car use
• Sporadic bike use (5 miles)
• Situational walking -- downtown
Moves to Milwaukee
Takes 2nd job
Takes 3rd job
Side trips
Time utilization
Bike tradeoff
Rain
Dark
Cold
Bike tradeoff
Exercise
Fun
Safety
Body Temperature
Personal achievement
Environmental friendliness
(--)
(-)
(-)
(+)
(+)
(+)
(+)
(+)
Refines routes
Layered clothing
Gas prices
Energy level
Time utilization
Repair expense
(++)
Car tradeoff
(-)
Mileage reinbursed
FUNCTIONAL
SOCIAL
PERSONAL
Kudos from coworkers
Connections to bike community
Car accident
Jan 2007
Feb 2007

APPENDIX Q. ORIGINAL FRAMEWORK AND GAM

This appendix is provided for historical purposes to describe the original theoretical framework and GAM prototype, four years prior to the beginning of this study. The GAM prototype in Figure 112 was developed and intentionally set aside long before the study began, consistent with good software engineering practice (Brooks, 1975). It reappeared quite unexpectedly at a much later date in modified form as the state diagram of the evaluation process (see Figure 55).

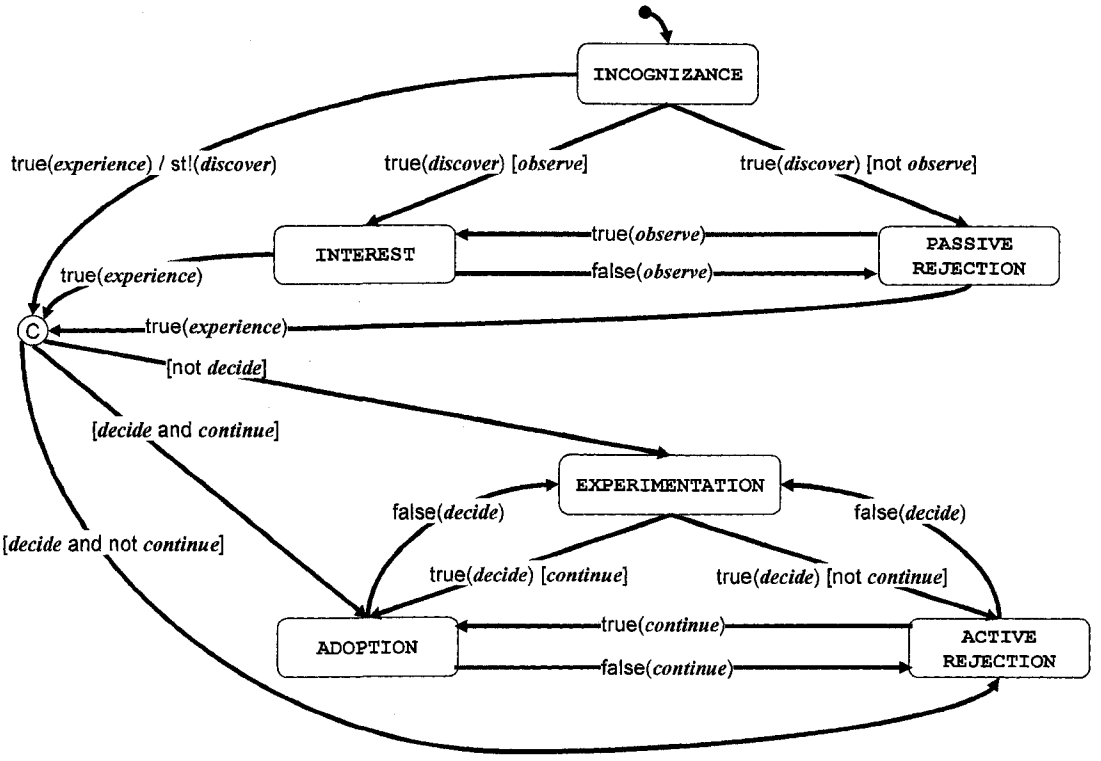


Figure 112. Original GAM Prototype

In its original form, the theoretical framework consisted of the following guiding propositions. Many of these were modified or eliminated from the final version of the theoretical framework.

TF-1. A **need** is a *state of being* in which something is wanted or required.

TF-1a. Needs come in two forms: desires and beliefs.

i. **Desires** pertain to functional purposes.

ii. **Beliefs** pertain to cultural and/or aesthetic assumptions.

TF-1b. Needs may be either latent, active, unmet, or satisfied.

i. A **latent need** is one which has not been consciously acknowledged by the decision maker.

ii. An **active need** has been consciously acknowledged, and a search and evaluation is currently in progress to find one or more technologies which satisfy that need.

iii. An **unmet need** has been consciously acknowledged, but a prior search and evaluation has failed to identify any technologies which satisfy that need.

iv. A **satisfied need** has been consciously acknowledged, and a prior search and evaluation has identified at least one technology which satisfies that need.

TF-1c. Three factors are necessary and sufficient to uniquely classify the state of any need:

i. Whether the need has been consciously acknowledged.

ii. Whether an acceptable solution has been found.

iii. Whether a search and evaluation process is currently taking place.

TF-2. A **technology** is a tool for extracting power from nature.

TF-3. During the **framing process (FP)**, the decision maker determines which needs are relevant to a decision episode.

TF-3a. The output of the framing process is a set of needs known as the **decision frame**.

TF-4. During the **technology adoption decision process (TADP)**, the decision maker forms an unconflicted association between a need and a technology which relates to that need.

TF-4a. The output of the TADP is a dyadic association is known as a **teme**.

TF-4b. Temes may be either evoked, inert, or inept.

i. **Evoked temes** are preferred need-technology pairs.

ii. **Inert temes** are backup need-technology pairs.

iii. **Inept temes** are unacceptable need-technology pairs.

TF-4c. Membership in the **evoked**, **inert**, and **inept sets** are determined by the set of needs which are included in the decision frame.

TF-5. During a **technology selection decision process (TSDP)**, the decision maker chooses a technology on the basis of existing temes.

TF-5a. The **selection set** consists of all technologies which are members of the evoked set, but are not members of the inept set.

TF-5b. The TSDP cannot terminate until the selection set contains *exactly one member*.

TF-5c. If the selection set contains *less than one member*, the decision maker will supplement the selection set with technologies drawn at random from the inert set.

TF-5d. If the selection set contains *more than one member*, the decision maker will supplement the decision frame with randomly chosen "outlier" or low-priority needs. Since this increases the size of the inept set, it effectively reduces the size of the selection set.

TF-6. An **innovation** is an emergent network of evoked temes associating one or more needs with one or more technologies. Innovations are not immutable 'things'; they are emergent macroscopic structures. Few definite statements can be made about them except that they are perceived and named by decentralized observers, and are generated by certain processes. These processes can be discovered and modeled in explanatory process theories which, when coded and installed in computer simulations, will generate running instances of these emergent structures.

APPENDIX R. THEORY-BUILDING

Case studies can be used to develop and test process theory frameworks, and this is the focus of Kathleen Eisenhardt's methodological approach (1989). Eisenhardt synthesizes and extends the frameworks of Yin (2003), Miles and Huberman (1994) and Strauss and Corbin (1998) to address the task of building process theory. She proposes an eight step framework:

1. Early Conceptualization
2. Case Selection
3. Instrumentation
4. Data Collection
5. Data Analysis
6. Hypothesis Generation
7. Comparison to Literature
8. Theoretical Saturation

Each of these steps will be discussed in turn.

R.1. Early Conceptualization

The initial step is to define a conceptual framework and design the research questions. These activities occur concurrently and iteratively (Eisenhardt, 1989; Miles & Huberman, 1994, pg. 22, 25). Eisenhardt stresses that the research questions and conceptual framework should be regarded as tentative at this stage; their purpose is to help provide focus to inquiry. The elements of the framework are not guaranteed a

place in the final theory, and the research questions may shift during the research (Miles & Huberman, 1994; Yin, 2003, pg. 120-122). Eisenhardt also emphasizes that theory building research should begin as much as possible without defining firm hypotheses to test or preconceived theoretical propositions. Obviously, there are tradeoffs involved here. The general idea is to begin with an initial framework to help provide focus, but also remain open to the possibility of revising the framework so as to limit the potential for bias and 'assumption drag'.

R.2. Case Selection

When designing a case study, two important decisions are whether to investigate one or multiple cases, and whether to employ one or multiple units of analysis (Yin, 2003). In resolving these decisions it is essential to develop an operational definition of the case.

Single case studies may be employed when the research investigates a critical case, as with Allison's (1971) study of the Cuban Missile Crisis. Single cases are also appropriate for situations which exhibit unique or extreme features, when the case is believed to be particularly revealing, or to illustrate a typical or longitudinal case (Dyer & Wilkins, 1991; Yin, 2003).

Both Yin and Eisenhardt argue that multiple case designs are generally more robust and should be employed whenever possible. Since each case represents a substantial time investment, considerable care must be exercised in selecting the cases. Yin (pg. 47) emphasizes the importance of *replication logic*, a quasi-experimental approach in which cases are selected because they predict similar or contrasting

results. This sampling strategy requires stating the conditions under which a particular phenomenon is expected to be found, as well as the conditions under which it is not.

There is no consensus on the minimum number of cases required. Guidelines range from "no more than four" (Creswell, 1998, pg. 63) to "four to ten" (Eisenhardt, 1989). Yin argues that the number of cases should be determined by the replication logic rather than in an arbitrary manner. It is important to select cases which will extend the theoretical framework and sharpen external validity (Eisenhardt, 1989).

Another important decision in designing a case study is whether to employ a single or multiple units of analysis. Yin (pg. 42-46) refers to a single unit of analysis as a 'holistic design'; it is useful when no naturally occuring subunits exist in the case. The entire episode is described holistically. Multiple units of analysis ('embedded designs') may be employed whenever distinct subthemes exist, either within or across the cases.

R.3. Instrumentation

One of the defining characteristics of case study research is its reliance on multiple sources of data (*data triangulation.*) These may include interviews, documents, archival records, direct and participant observation, and physical artifacts. The exact mix should be determined by the *case study protocol.* The protocol for each case typically includes an overview section, a description of the data collection procedures (i.e., types of data to be collected, access strategies, schedules, sampling procedures, screening procedures), the questions to be asked of the respondents and

about the case itself, and a tentative outline of the case study report (Yin, pg. 67-77, 86).

Interviews are a typical part of data collection. Interviews may be loosely structured when the goal is exploration of a poorly understood area (e.g., to generate items for a survey instrument), to avoid biasing data collection, or to include rich context (Miles & Huberman, 1994, pg. 35; Easterby-Smith et al., 2002, pg. 87-88). More structured interviews are appropriate when the researcher already knows a lot about the topic and wishes to avoid gathering extraneous data, to develop an initial theoretical framework, or to confirm the validity or elicit knowledge about known items (Johnson & Weller, 2002, pg. 494).

R.4. Data Collection

In multi-case research data collection and analysis are iterative and overlapping (Eisenhardt, 1989, pg. 538; Miles & Huberman, 1994; Yin, 2003). A case is selected; data are collected within that case; within-case analysis takes place; the case report is written; then the process repeats until theoretical saturation occurs, when new insights stop emerging from the data because the bulk of relevant content has already been sampled. Then cross-case analysis takes place and the final case report is written.

Process research approaches the issue of sampling in a different manner than variance research. The goal of variance research often involves drawing statistically valid inferences about populations. By contrast, process research seeks to sample cases and informants in a way that advances the development of explanatory theory. Since

process research needs to sample content rather than populations, it replies on purposeful (or theoretical) sampling rather than statistical sampling. This has important consequences; process research is generalizable with respect to theoretical propositions rather than populations (Yin, 2003, pg. 10).

Several authors describe strategies for purposeful sampling in qualitative research (e.g., Patton, 1990; Kuźel, 1992; Miles & Huberman, 1994; Creswell, 1998). Miles and Huberman's summary of these methods is shown in Table 28.

TABLE 28. STRATEGIES FOR PURPOSEFUL SAMPLING (MILES AND HUBERMAN, 1994)

Type of Sampling	Purpose
Maximum variation	Documents diverse variations and identifies important common patterns
Homogeneous	Focuses, reduces, simplifies, facilitates group interviewing
Critical case	Permits logical generalization and maximum application of information to other cases
Theory-based	Finding examples of a theoretical construct and thereby elaborate and examine it
Confirming and disconfirming cases	Elaborating initial analysis, seeking exceptions, looking for variation
Snowball or chain	Identifies cases of interest from people who know people who know what cases are information-rich
Extreme or deviant case	Learning from highly unusual manifestations of the phenomenon of interest
Typical case	Highlights what is normal or average
Intensity	Information-rich cases that manifest the phenomenon intensely, but not extremely
Politically important cases	Attracts desired attention or avoids attracting undesired attention
Random purposeful	Adds credibility to sample when potential purposeful sample is too large
Stratified purposeful	Illustrates subgroups; facilitates comparisons
Criterion	All cases that meet some criterion; useful for quality assurance
Opportunistic	Following new leads; taking advantage of the unexpected
Combination or mixed	Triangulation, flexibility, meets multiple interests and needs
Convenience	Saves time, money, and effort, but at the expense of information and credibility

Different units are used for cross-case and within-case sampling. The units of cross-case sampling are cases, which are selected to maximize the potential to

contribute to the developing framework. Yin's replication logic is a quasi-experimental approach which operates at the level of cross-case sampling. The units of within-case sampling are typically individuals, who are selected on the basis of their ability to contribute to the understanding of the case.

R.5. Transcription and Coding

Transcription has received comparitively less attention than other aspects of data collection (Miles & Huberman, 1994, pg. 56, 89; Poland, 2002). Poland identifies several methodological and ethical issues which lurk in the transcription process, such as superficial coding, decontextualization, missing inflection, and diminished social presence. He gives some practical guidance on tape recording and notating transcripts, while Miles and Huberman feature an extensive discussion of coding, marginal notes, and memoing issues (Miles & Huberman, 1994, pg. 55-76).

Coding is an analytical tool which can be pursued in varying degrees. For example, *template analysis* (Crabtree & Miller, 1992; King, 1998) is an *a priori* approach to coding themes. It is conceptual similar to theory building, except that its scope is more narrowly defined. During template analysis the researcher produces a hierarchical list of initial codes for themes which are expected to be encountered during data analysis. King warns that these initial templates should not be regarded as sacrosanct; rather, they should considered to be tentative and refined as data collection and analysis proceed. Unfortunately, he also notes that relatively little practical guidance is available for conducting template analysis (King, pg. 133).

R.6. Data Management

Case studies produce a large volume of data, which poses data management problems. It can be difficult to ensure that all the planned data have been collected for each case and that no data are missing; Miles and Huberman (pg. 80-81) propose a simple mechanism called a *data accounting sheet* to help remedy this problem.

Several different examples of *computer-assisted qualitative data analysis software* (CAQDAS) are available to help manage data collection and analysis. Review articles about CAQDAS products (Miles & Huberman, 1994, pg. 311-317; Easterby-Smith et al., 2002, pg. 127-129; Seale, 2002; Yin, 2003, pg. 110) together with materials obtained from the web suggest that the software applications best-suited to the needs of this project are Atlas-ti (http://www.atlasti.de) and NUD*IST (http://www.qsr.com.au). These two products, together with Ethnograph (http://www.QualisResearch.com) dominate the CAQDAS market. Atlas-ti is especially geared toward the development of grounded theory. NUD*IST, on the other hand, contains a number of features which may be used to generate the matrices and causal networks which are central to Miles and Huberman's style of analysis.

R.7. Data Analysis

Data analysis – particularly cross-case analysis – is the least developed aspect of the case study method (Eisenhardt, 1989; Yin, 2003, pg. 109). Fortunately, Miles and Huberman (1994) is a classic sourcebook for case studies which emphasize innovation adoption; numerous examples of TADP research are scattered throughout the text.

Miles and Huberman advocate constructing analytical matrices from coded, context-bound case data. Matrices are useful for comparing two dimensions of the data to explore and describe cases and conduct variable-oriented analysis and theory building. Their basic approach is very flexible, and may be applied to diverse types of data pertaining to critical incidents, roles, concepts, and so forth.

R.8. Hypothesis Generation

An important step in establishing the internal validity of a case study and the construct validity of an emerging theoretical framework is to generate and test predictive hypotheses. Miles and Huberman outline some general strategies for generating hypotheses: (pg. 172-177)

- In *case-oriented analysis* one case is analyzed in depth, then successive cases are used to confirm whether the initial conclusions hold. Miles and Huberman cite Yin's replication logic as an example of this approach.
- *Variable-oriented analysis* looks for predictor variables which cut across cases.
- *Hybrid analysis* mixes the case-oriented and variable oriented approaches.

When the goal is to develop explanatory process theory Miles and Huberman recommend identifying variables which may be used to predict outcomes. This approach is akin to what Yin calls pattern matching (Yin, 2003, pg. 116-118).

Predictor variables, in the context of this study, could correspond to the dichotomous classification factors which identify the TADP state of survey respondents. At least two types of hypotheses could be generated for these variables:

- Hypotheses predicting which classification variable values would trigger automaton state changes.
- Hypotheses predicting which classification variable values would coexist with other values.

Quasi-experimental test cases could be set up using Yin's replication logic. Hypothesis testing would be judgmental in nature, since these data do not lend themselves to statistical inference (Eisenhardt, 1989). These predictions could be compared to rival classifications obtained from the Concerns-Based Adoption Model (CBAM, Hall et al., 1975) or the Transtheoretical Model (TTM, Prochaska & DiClemente, 1984; Prochaska et al., 1992).

R.9. Comparison to Literature

When building theory from case study research, Eisenhart stresses that it is important to compare the emerging theoretical framework with the existant literature. This requirement stems in part from the limited sample sizes in case study research and from the need to break the analysis out of limited ways of viewing the data. Highlighting similarities and differences with the literature can help to raise the theoretical level, improve the generalizability of the findings, and strengthen the internal validity of the study (Eisenhardt, 1989).

R.10. Theoretical Saturation

Data collection and analysis conclude when *theoretical saturation* is achieved. At this point, collecting additional data results in only marginal improvement because the most relevant phenomena have already been recorded and analyzed. Pragmatic considerations also factor into theoretical saturation, such as limited time and money for continuing the research. At this stage the final case report is written up and the study concluded.

R.11. Evaluation Standards

Quantitative evaluation criteria such as internal and external validity, generalizability, and reliability entail certain assumptions that are inconsistent with the philosophies of science which underpin qualitative research. Many efforts have been made to reconcile these differences, either by redefining or reconceptualizing quantitative standards within a qualitative context (e.g., LeCompte & Goetz, 1982), by proposing entirely new alternative standards for evaluating qualitative research (e.g., Lincoln & Guba, 1985; Stewart, 1998; Arnould & Epp, 2006), or by dismissing such debates as semantic distractions (Wolcott, 1994). Regardless of the particular names which are used, it is clear that different criteria are needed to evaluate qualitative research. This section examines some of the qualitative alternatives which have been proposed for internal and external validity, generalizability, and reliability.

In quantitative research, internal validity gets at the question of whether an instrument measures what it purports to measure. Such a criteria presupposes that a single correct view of reality exists, an assumption at odds with the social

constructivist foundations of qualitative research. *Credibility* (whether interpretations are adequate or believable) and *veracity* (truthfulness of depiction) are proposed alternatives to internal validity which avoid making this assumption (Lincoln & Guba, 1985; Stewart, 1998; Arnould & Epp, 2006). A variety of techniques are available to strengthen credibility, such as prolonged engagement and persistent observation; triangulation of methods and different classes of informants; informant member checks; and face validity. Veracity may be enhanced by linking findings to context; employing multiple methods of data collection; and searching for disconfirming cases.

In quantitative research, generalizability refers to the extent to which findings are applicable to other populations. However, qualitative research does not sample populations – it samples theoretical propositions (Yin, 2003, pg. 10). Maxwell (1996, pg. 96-98) argues that it is important to distinguish between internal and external generalizability when assessing the applicability of qualitative research. Internal generalizability refers to the applicability of the conclusions within the immediate substantive setting or group under study, and external generalizability refers to the applicability of the conclusions beyond that context. Maxwell considers internal generalizability much the more important of the two, with external generalizability viewed as either a minor concern or counterproductive to the aims of the study. In cases where generalizability is not seen as appropriate standard, two proposed alternatives are *perspicacity* (the ability to convey new understanding and insight into the data) and *transferability* (the extent to which these insights can be employed in other contexts) (Lincoln & Guba, 1985; Stewart, 1998; Arnould & Epp, 2006).

Methods for strengthening these include actively identifying boundary conditions to explain where and why an interpretation fails, and theoretical sampling to ensure a diversity of sites, settings, events, and classes of informants.

In quantitative research, reliability refers to the likelihood that similar findings would be reached by other researchers. However, qualitative research investigates social phenomena which are inherently context-bound, dynamic, and not replicable; thus, alternative standards are needed. *Dependability* is proposed as the ability to construct an interpretation that excludes sources of instability other than those which are intrinsic to the phenomenon itself (Lincoln & Guba, 1985; Stewart, 1998; Arnould & Epp, 2006). There are several methods for strengthening dependability, such as employing longitudinal data collection; using multiple data collection methods with the same informants; using multiperson teams; asking informants and knowledgeable authorities to verify findings with the intention of reducing bias; and describing the context of the findings in sufficient detail that they could potentially be disconfirmed by a follow-up study.

Confirmability refers to the ability to reconstruct the researcher's interpretations by examining data trails and other records of the research process (Lincoln & Guba, 1985; Stewart, 1998; Arnould & Epp, 2006). Techniques for strengthening confirmability include disciplinary triangulation; qualitative and quantitative data triangulation; personalized journal writing; and using an outside auditor to examine the correspondence between the data and the report.

Integrity refers to the extent to which interpretations are unimpaired by informant lies, evasions, misinformation, or misrepresentation. Techniques for improving integrity include prolonged engagement; development of rapport and trust between researchers and informants; triangulation; good interviewing technique; ensuring informant confidentiality; and personalized journal writing (Lincoln & Guba, 1985; Stewart, 1998; Arnould & Epp, 2006).

APPENDIX S. FOLK UTILITY

As solutions settle into habits, we easily fall into a pattern of categorizing or pigeonholing our reasons for using or rejecting technologies. We speak of show-stoppers, contenders, longshots, drawbacks, or perks, but seldom do we reflect on precisely what these terms mean or what they might imply about the decision making process. Yet shorthand expressions such as these can reveal hidden insights into the sense-making aspects of adoption. Since philosophers refer to commonsense systems of meaning as folk theories, it is useful to refer to these informal expressions by the collective term *folk utility*. By conducting a microanalysis of these folk utility expressions and restating them in formal, operational terms, we can gain new insight into the nature of technological innovation. We will turn our attention to two groups of idiomatic, adoption-related expressions: beliefs about technologies, and beliefs about motives.

S.1. Technological Pigeonholes

Selecting, evaluating, and maintaining revolve around seven criteria:

- Is this option relevant to my needs? (*Relevance*)
- Have I previously used this option to meet my needs? (*Familiarity*)
- Is this option worthwhile, counterproductive, mixed, or of unknown worth in terms of meeting my needs? (*Valence*)
- Can I obtain this option? (*Obtainability*)
- Do I already have this option? (*Accessibility*)

– Does this option function? (*Operability*)

– Is my need in the present or the future? (*Timing*)

It is revealing to look at valid combinations of these criteria (see Table 29.) These combinations are not independent, but cluster naturally into pigeonholes such as 'longshots', 'nonstarters', and 'contenders'. Since these categories refer to options rather than motives, it is useful to refer to them as 'technological pigeonholes.'

TABLE 29. TECHNOLOGICAL PIGEONHOLES (TABULAR VIEW)

Relevance	Obtainability	Timing	Accessibility	Operability	Familiarity	Valence	Pigeonhole
X	X	X	X	X	Familiar	Unknown	(invalid)
Irrelevant	*	*	*	*	*	*	Nonsequitur
Relevant	Unobtainable	*	Inaccessible	*	*	*	Moot
Relevant	Unobtainable	*	Accessible	Inoperable	*	*	Moot
Relevant	Obtainable	Present	Inaccessible	*	*	*	Moot
Relevant	Obtainable	Present	Accessible	Inoperable	*	*	Moot
Relevant	Unobtainable	*	Accessible	Operable	Unfamiliar	Negative	Nonstarter
Relevant	Obtainable	Future	*	*	Unfamiliar	Negative	Nonstarter
Relevant	Obtainable	Present	Accessible	Operable	Unfamiliar	Negative	Nonstarter
Relevant	Unobtainable	*	Accessible	Operable	Familiar	Negative	Reject
Relevant	Obtainable	Future	*	*	Familiar	Negative	Reject
Relevant	Obtainable	Present	Accessible	Operable	Familiar	Negative	Reject
Relevant	Obtainable	Future	Inaccessible	*	Unfamiliar	Unknown	Longshot
Relevant	Obtainable	Future	Accessible	Inoperable	Unfamiliar	Unknown	Longshot
Relevant	*	*	Accessible	Operable	Unfamiliar	Unknown	Longshot
Relevant	Obtainable	Future	Inaccessible	*	*	Mixed	Mixed Bag
Relevant	Obtainable	Future	Accessible	Inoperable	*	Mixed	Mixed Bag
Relevant	*	*	Accessible	Operable	*	Mixed	Mixed Bag
Relevant	Obtainable	Future	Inaccessible	*	*	Positive	Possibility
Relevant	Obtainable	Future	Accessible	Inoperable	*	Positive	Possibility
Relevant	*	*	Accessible	Operable	*	Positive	Contender

X = undefined value; * = any value

Truth tables are difficult to read since they do not take the order of evaluation into account. But if we evaluate these conditions one at a time and define 'ready to

use' as the combination of (accessible + operable), then we can redraw Table 29 as a hierarchy:

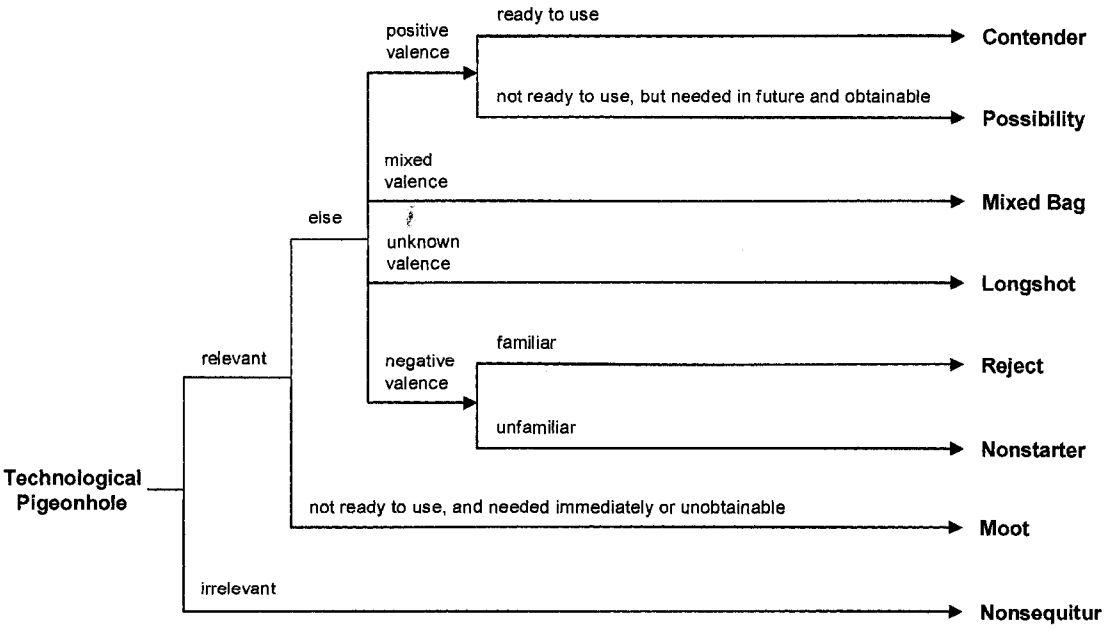


Figure 113. Technological Pigeonholes (Hierarchical View)

Even if these informal names are culture- and language-specific, the resulting pigeonholes do seem to be expressing something essential about human decision making:

- A *nonsequitur* is an option which is irrelevant to the need at hand. For example, a garden hose is no help in terms of getting to work.
- An option which is *moot* is currently inaccessible and/or inoperable, and is excluded from consideration because it is (1) needed immediately, or (2) needed in future but unobtainable. If you needed to leave for work right away, a bicycle would be moot if you did not own one (present need + inaccessible) or if it had a flat (present need + inoperable.) Even if you

didn't need to go to work until later in the week a bicycle would still be moot if your town had no bike shop to repair the flat (future need + inoperable + unobtainable.)

- A *nonstarter* is an option which has been dismissed prior to initial use because of negative valence. For example, someone might decide not to attend a play after reading an unfavorable review in the newspaper.
- A *reject* is an option which has been dismissed after initial use due to negative valence. For example, a computer user might conclude that Windows Vista is no longer worth the trouble it causes, and decides to switch to Macintosh.
- A *longshot* is an unfamiliar option of unknown value. For example, several informants knew of Flexcar, but held no opinion of the service and had knew very little about it except that it existed.
- A *mixed bag* is an option with both positive and negative aspects. For example, informant #4 used Flexcar for many years and developed a nuanced view of it which was neither wholly favorable nor unfavorable.
- A *possibility* is a option under consideration for future use which is relevant, obtainable, and has positive valence – but which is inaccessible or inoperable at the present time. Informant #8 formed an early intention to use Flexcar as a solution to her family's transportation crunch, but delayed signing up for the service for several months because she did not perceive an immediate need.

– A *contender* is an option which is relevant, accessible, operable, and has positive valence. As long as the option is ready to use, it does not matter whether it is obtainable. One of my favorite computer games is the Windows 3.1 version of Risk. It still works, but should I ever lose it I might find it difficult if not impossible to replace.

Maintenance plays an important role in determining whether an option is viable. Basic viability is determined by relevance, obtainability, accessibility, operability, and timing. By contrast, valence and familiarity tend to be used to resolve tradeoffs during the choice stage, after viability has been established (Figure 114.)

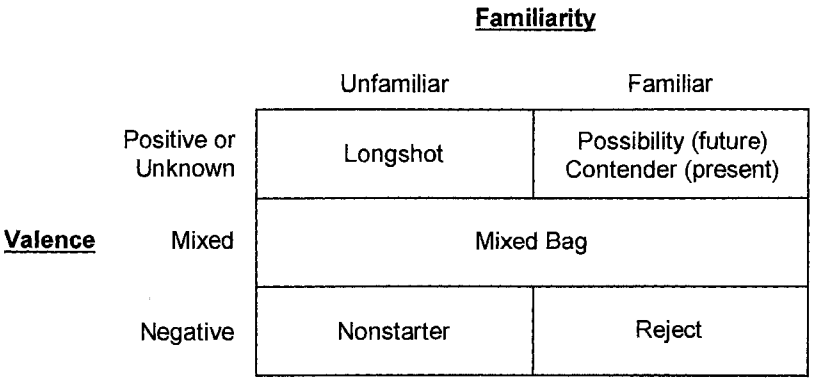


Figure 114. Resolving Tradeoffs: Familiarity and Valence

S.2. Motivational Pigeonholes

A second set of pigeonholes refers to the reasons behind a decision, whether pro or con. Five 'motivational pigeonholes' emerged from the grounded analysis: clinchers, perks, washes, drawbacks, and show-stoppers. A microanalysis of these

reasons revealed that they originate in the capabilities and requirements of each option. They can be distinguished by four criteria:

- Does the reason refer to a capability or a requirement? (*Polarity*)
- If the reason refers to a capability, it is useful at solving a requirement? If it is a requirement, is it solved by a matching capability? (*Reciprocity*)
- If it is a capability which solves a requirement, is that requirement germane to the decision frame, or is it extraneous? (*Topicality*)
- If it is a capability which solves a germane requirement, are there other options which offer similar capabilities, or is the capability unique to this option? (*Exclusivity*)

The truth table for these criteria is shown in Table 30.

TABLE 30. MOTIVATIONAL PIGEONHOLES (TABULAR VIEW)

Polarity	Reciprocity	Topicality	Exclusivity	Pigeonhole
Requirement	Unmatched	X	X	Show-Stopper
Requirement	Matched	X	X	Drawback
Capability	Unmatched	X	X	Dunsel
Capability	Matched	Extraneous	X	Perk
Capability	Matched	Germane	Common	Wash
Capability	Matched	Germane	Unique	Clincher

X = undefined value

On the basis of this analysis a previously unsuspected sixth pigeonhole was identified, the dunsel. Figure 115 expresses the truth table as a hierarchy:

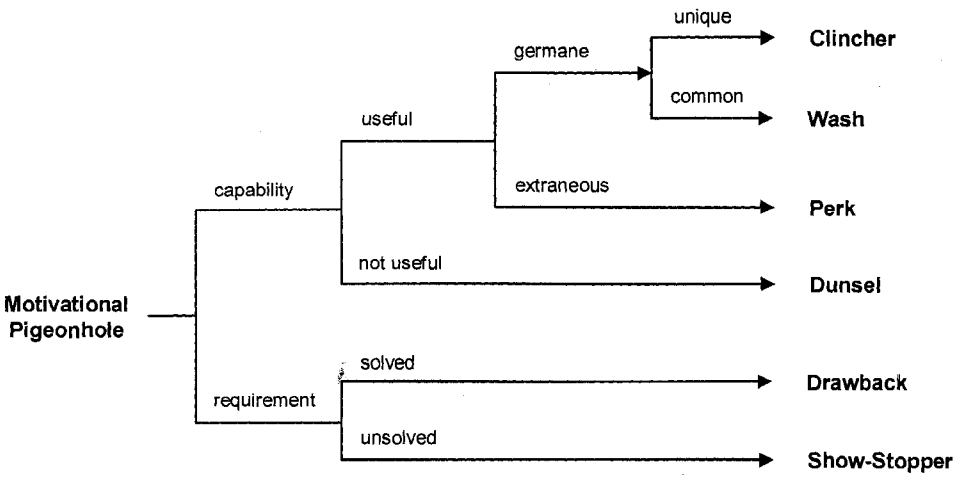


Figure 115. Motivational Pigeonholes (Hierarchical View)

S.2.1. Show-Stoppers

A *show-stopper* is an optional requirement with no satisfactory solution. It is a factor beyond the user's control which cannot be 'spun' or reframed; there is simply no getting around it. A show-stopper is a decisive reason against selecting an option:

> "I could ride my bike to the Park and Ride and leave my bike. They have those covered things that are locked; so I could leave the bike there. But it's my backpack. People tease me that I have enough stuff in there to…I could go for a week and not ever have to…I mean, I've got saline solution for my contacts; I've got my CD player; and my lunch, usually. And you know…snacks and various things. So, it's a day pack backpack. I put this in it. [#14 indicates a large purse] I feel safer if my purse is inside the zipped backpack. Umbrella, you know, everything. And then, plus with my workout bag, that has my workout clothes and my shoes and stuff in it, I thought 'How can I do that on my bike?' I really can't." [#14]

A show-stopper has negative utility and always manifests itself as an absence of something needed.

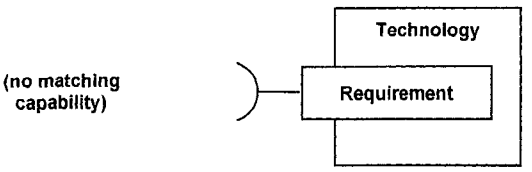


Figure 116. Show-Stoppers

S.2.2. Drawbacks

A *drawback* is an optional requirement with a satisfactory workaround.

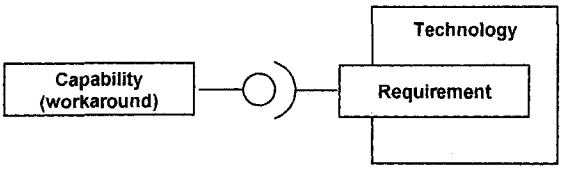


Figure 117. Drawbacks

After biking to work a person might need to shower and change clothes. If there are shower and locker facilities at work, then a workaround exists and the reason would be seen as a drawback. But if no such facilities exist and no other workaround can be found, then the reason would be seen as a show-stopper.

A drawback has negative utility, but it is generally not grounds for excluding an option *unless* a rival offers a superior solution, *or* the option imposes too many drawbacks, *or* if a workaround fails to materialize. Drawbacks are risky, of course, since they can devolve into show-stoppers, but users are forgiving up to a point. Beach and Strom (1989) found that tolerance for drawbacks runs out at around four violations.

Drawbacks can change into show-stoppers (and vice versa) as a result of the maintenance process; for example, a printer may run out of ink, rendering it inoperable. When an option stops providing certain capabilities, any bundled

technologies which depend on these capabilities may also become inoperable (see Figure 118).

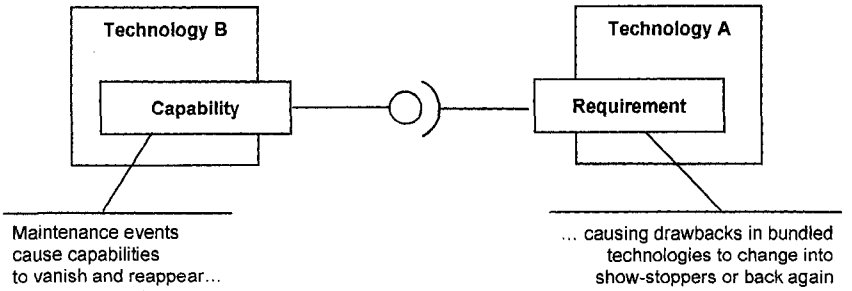


Figure 118. Bundles and Maintenance Events

S.2.3. Dunsels

A *dunsel* [5] is a capability so useless it cannot even be regarded a perk.

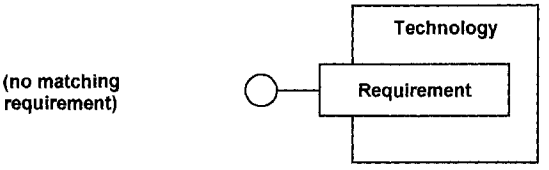


Figure 119. Dunsels

During the late 1980s, the ISDN digital telephone service became disparagingly known as "innovation subscribers don't need." Some informants came to regard Flexcar's capabilities as dunsels:

> "I was a [Flexcar] member, because I got this free membership. And I never actually used it. I signed up for it: 'This is great! I don't have a car at work, and I need a car to go somewhere.' And there's like 10 of them within a block of this building. But I've never used it. It turns out that when you're here you don't need a car for any place you want to go. It's all within walking distance, or you can easily just hop on the bus, or I've got my bike. So if I want to go somewhere, and I don't want to do it on the bike or the bus, it's because, you know, I need to get home with some big piece of furniture. And then, of course, I need to take it all the way home, not here. So the Flexcar doesn't help a whole lot. I signed up for it right away when I got my

[5] The term 'dunsel' was first coined in an episode from the original 1960s *Star Trek* television series.

> transit pass, because it was free. If there was one within walking distance of my house I would sell my car, I think. But there isn't." [#5]

A dunsel can become a drawback if an option includes are too many of them, or if they begin to interfere with the other capabilities of the option – a condition known variously as 'feature creep', 'feature fatigue', or 'featuritis' (Thompson et al., 2005). The notorious animated paperclip from Microsoft Office 97 is a classic example of a dunsel that backfired: not only did the paperclip serve no useful purpose, it created an annoying distraction. Thus, a dunsel is a capability with negative utility.

S.2.4. Perks

A *perk* is useful, but not in a way that is germane to the decision frame.

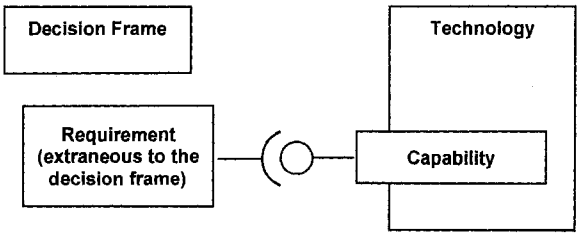


Figure 120. Perks

A perk is an excess capability, a side benefit which provides a mildly positive utility. Several informants described the 'green' benefits of public transit and bike commuting as something of a perk:

> "I don't ride to do good. Doing good is a side benefit; it's a perk. That's not what motivates me to get up and get on my bike every day. I get on it because I enjoy it. I like getting exercise every day; I like the way I feel. I just enjoy being out there, riding. It's something I've enjoyed doing all my life." [#22]

S.2.5. Washes

A *wash* does something which is useful and germane, but not unique; other options provide similar capabilities. There is a paradoxical aspect to washes. They are undeniably useful, and should have positive utility if considered in absolute terms. For example, the ability of a cell phone to place a call is still beneficial, even if all other cell phone provide that same capability. However, washes are not helpful in resolving tradeoffs among options, so they cancel each other out and drop out of consideration (Kahneman & Tversky, 1979; Montgomery, 1983). They are so taken for granted that they may be seen to provide *no* utility. They become a desensitized part of the background, and even mentioning their existence may risk a dismissive response.

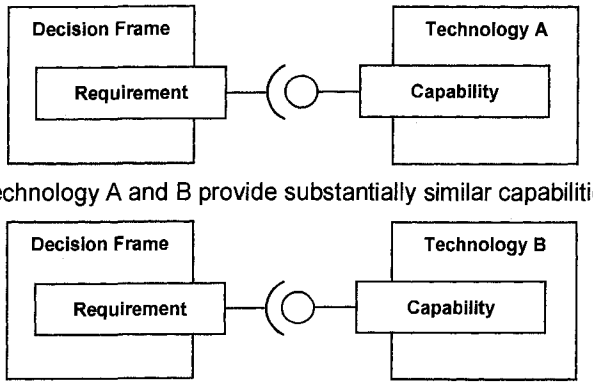


Figure 121. Washes

When selling bike commuting to his friends informant #4 considered its 'green' benefits to be a wash.

> "If everybody's using the same argument then it doesn't really carry a lot of value. [Laughs] If everybody's sort of beating on the environmental drum, one more guy beating on the drum is not going to make a huge difference. The environmental aspect is there, though it's not one I think about a whole lot. I think that argument is taken

care of well by others in the community who speak more eloquently towards that than I will, and I don't sell that argument well within my group of friends. I think of the fun aspect when I'm selling [bike commuting] to friends, and there's definitely sort of an identity thing built into it." [#4]

S.2.6. Clinchers

A *clincher* is a capability which is useful, germane, and unique. Uniqueness is defined as a level of performance that no rival can match, either because they lack the capability or because their capability is of inferior quality. Differences in performance are always judged with respect to the situation; it is futile to offer capability in excess of the requirements. For example, a car offers greater range than a bicycle, but this additional range is immaterial if the situation only involves a trip of a few blocks.

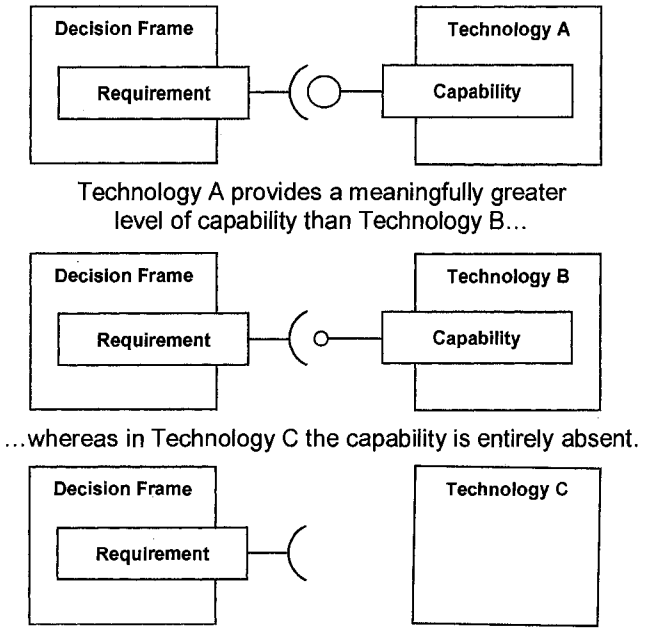


Figure 122. Clinchers

Due to their uniqueness, clinchers loom large. A clincher is a tie-breaker:

> "[On campus] parking, the math doesn't make sense. You look at, what, 70 bucks a month for staff to have a parking pass here? I thought 'Well, I can give myself a thousand dollar raise by just taking a bus.'" [#4]

Although a clincher is a decisive reason for choosing an option, it may not be openly revealed – especially if the clincher might expose the consumer to guilt, shame, embarassment, criticism, retaliation, disapproval, financial loss, or other adverse consequences. An *ulterior motive* is a clincher concealed behind a *pretext* – a motive which is presented as a socially acceptable public front. Typically a pretext is a legitimate motive, but not a genuine clincher; it is only espoused to be a clincher. Often a pretext is simply an exaggerated wash, perk, or dunsel. Usually framing is used in conjunction with a pretext to make rivals appear more unattractive by limiting the alternatives to a single rival with known show-stoppers, or one whose drawbacks can be easily misrepresented as show-stoppers. This process may or may not take place on a conscious level: we can deceive ourselves. Depending on the extent to which we have unpacked our own motives, we may reach a decision in denial of the actual hedonic desires which are motivating the clincher. We learn early in life that the proferred reasons for decisions are not always the real reasons. Knowing that deception is possible, we develop 'theories of mind' to guess at clinchers, for we know these can reveal a lot about a person.