Merry Miser

by

Charles DeTar

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Abstract

This thesis describes the design, implementation, and evaluation of Merry Miser, a persuasive mobile phone application intended to help people to spend less and save more. The application uses the context provided by users' location (obtained using the phone's GPS) and financial histories to provide personalized interventions when the user is near an opportunity to spend. The interventions, which are motivated by prior research in positive psychology, persuasive technology and shopping psychology, consist of informational displays about context-relevant spending history, subjective assessments of purchases, personal spending limit contracts, and a glanceable display of the user's current financial status and savings goals. The application was tested with four users over a period of four weeks. The test results are described, and additional steps to improve the application are suggested.

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Contents

Chapter 1

Introduction

Merry Miser is a mobile application which persuades people to spend less money, and think more about their spending. By combining users' real financial transaction information, their location, and personal assessments of spending, the application presents deeply personalized and compelling interventions at the time and place when they are near an opportunity to shop. The interventions help to reinforce choices that are in the users better long-term self interest, against short-term impulses.

1.1 Scenario

Jim is a new college graduate. He has just started a new job, and for the first time is making a salary — enough to have some money to spare, and he even has time to enjoy it. He starts spending a fair amount on meals, nights out with friends, clothes, and electronics for his somewhat pricey apartment. Things are going well, but then he notices that his paycheck is not quite cutting it each month. He has a credit card he's been using, and can make the payments, but he doesn't have much of a cushion. In addition, he still has some student loans that he hasn't payed off looming over him. He'd like to reel in his spending and get a little control over his finances.

Jim installs "Merry Miser", a downloadable application, on his smart phone. The application downloads his bank statements and tracks his location, and presents him with interventions when he goes shopping. The interventions consist of useful tools to

help him control his behavior, such as the ability to make contracts with himself. The application also prompts him to assess how happy he feels about the purchases he is making, and to think about how his perception on the value of a purchase changes over time. The application gives him a mechanism to set saving goals — Jim picks paying off his student loans and a vacation trip to Mexico. The application shows him a glanceable visualization of the current state of his accounts that makes it easy to see his progress towards these goals. In no time, Jim has started saving, and feels better about himself. He even has enough left over each month that he can give some to a local charity, for which the application rewards him.

1.2 Goals for this thesis

The aim of Merry Miser is to help people to make better choices about money. But what does "better" mean? In what way can someone be "helped" to make a better choice? Both of these questions involve value assessments that can become contentious, culturally contextual, or intrusive, depending on how they are handled. Developing an intervention in this field requires the designer to make design decisions based on highly conflicted research in multiple fields, straddling different areas of political, personal, and practical judgment.

My personal motivations in this application arise from my opinions: I believe that people would be happier if they buy less stuff, lead less stressful lives, and save more. But these are beliefs that I can't prove — every part of them is steeped in conflicted value judgments, including the meaning of happiness, the resulting effects of increased saving on the economy, and what qualities make a life worthwhile. A savvy researcher working in the fields of economics or positive psychology could find peer-reviewed, well referenced and reproducible research that would support almost any opinion she or he might have. The fact is that these areas of research are steeped with moral and ideological beliefs, with few decisive conclusions and plenty of questionable research methodology. Though they strive to be empirical, their questions and results suggest as much affinity to philosophy, with its accompanying constitutional discord.

In this thesis I hope to accomplish two goals: to lay out a rough map of four research areas essential to Merry Miser (spending behavior, happiness, persuasive technology, and location based services), and then to give a detailed description of the application design, user evaluation, and areas for future improvement and research. I don't expect to be able to answer definitively whether the approach taken by Merry Miser is the best approach to the problem at hand, nor whether my take on positive psychology, economics and persuasive technology is correct. I believe that a researcher in this field would be best served by understanding and engaging with the fields' inherent conflicts and contradictions, rather than choosing a side and pretending that it is correct, and I hope to present a balanced perspective which makes this possible.

Chapter 2

Background

Merry Miser draws on research in the psychology of finance, positive psychology, persuasive technology, and location based services. The following sections describe the background and relevant prior work in these fields.

2.1 The problem of spending

Many Americans carry excessive debt. For years, the rate of individual bankruptcy filings has been increasing, with a high cost to people's lives, the economy, and lending institutions (Bhandari & Weiss 1993, Weston 2005*a*). While consumer culture continues to promote unchecked consumption without responsibility (Roberts & Jones 2005), credit card companies offer increasingly easy lines of credit against the borrower's best interest (Weston 2005*b*), and Americans continue to have poor financial literacy and responsibility necessary to bring them out of debt (Duguay 1998). The problem has grown severe enough that politicians cite credit card reform as key components of their economic platforms (Lopes 2008).

These trends — dramatically increasing debt and spending rates, and dramatically shrinking savings rates — have been encouraged by consumer marketing for producers who benefit from these tendencies to largesse. For the last 80 years, advertising has focused on emotional and unconscious appeals, brand-centric tribalism, and direct and intentional appeals to the irrational aspects of consumers (Stole 2006,

p 16). This has helped to cultivate a consumer culture in which many people will irrationally choose short-term pleasure in the form of impulsive purchases over long-term happiness and financial well-being (Manning 2000, p 3). Numerous studies show that people are happier when they lead simpler lives with fewer possessions and more free time (Frank 2004). Still, advertisers, credit card companies, and banks continue to promote lifestyles that run in the opposite direction, with increasing debt, more purchasing, and inevitably longer hours of work and higher stress (John De Graaf 2001, p 13).

In 2006, the US savings rate hit a historic low, reaching below zero percent (Gardner 2006). However, as the economic crisis in 2008 grew deeper, spending and savings trends reactionarily reversed themselves, with savings rates growing higher than they had in a decade in the first quarter of 2009 (U.S. Bureau of Economic Analysis 2009), leading some analysts to decry this explosion in saving and decrease in spending as a force deepening and prolonging the recession. Kelly Evans of the Wall Street Journal writes: "Usually, frugality is good for individuals and for the economy. Savings serve as a reservoir of capital that can be used to finance investment, which helps raise a nation's standard of living. But in a recession, increased saving . . . can exacerbate the economy's woes. It's what economists call the 'paradox of thrift.'"(Evans 2009) The boom-and-bust cycle of consumer spending clearly causes problems for the economy — it would be far preferable for consumers to practice consistent long-term frugality and reasonable saving. However, most people's attitudes toward money are not built on careful analysis and rationality. While many different models have been proposed to describe consumer behavior[1], that of a "rational agent" has long been discredited.

Advertisers are keenly aware of, and frequently make efforts to exploit, people's inherent irrationality. The form of this rationality has been widely studied, both in the academy and through advertisers' own empirical analysis, and found to have some predictable aspects (Ariely 2008). Besides contributing to the ease with which people

[1]Judith Zaichkowsky proposes in her article in Business Horizons that models of consumer behavior has passed through multiple paradigms, including that of a rational economic agent, an irrational manipulable agent, a problem solver, a cognitive miser, and a collective buyer (Zaichkowsky 1991).

can be persuaded to take actions against their best interest, irrationality manifests itself in the difficulty people have in fulfilling their best intentions with regard to diet, exercise, savings, fidelity, and any other area where short term pleasures might outweigh long-term self interest. A challenge consumers face is finding a way to judge the myriad sources of information to which they have access regarding spending decisions, when many of those sources are not motivated by the consumer's best interest, and may instead be seeking to titillate short-term desires.

Another challenge in making decisions about spending is that, unlike other potentially harmful addictions like cigarettes or alcohol, it is generally considered impractical to stop spending entirely[2]. How does one determine which spending is problematic, and which is acceptable? In discussions about frugality, the popular press, the blogosphere and self help books often place great importance on a distinction between "deliberate" and "impulsive" purchases (Karp 2008, Wynne 2008, Sander & Sander 2005). Among rigorous studies, however, even those that honor this distinction substantially problematize it (Kollat & Willet 1967, Lee & Kacen 2008, Thompson et al. 1990, Nelson 1970). What counts as "impulsive"? In his 2005 study, Michael Wood decries the single-mindedness of popular literature that depicts impulse buying as "extraordinary, emotion-saturated buying that takes place largely without regard to the consequences" (Wood 2005, p 269). The more common reality is far more mundane. People often make purchase decisions in stores, and often reasonably and even frugally — one might be reminded of a forgotten need (e.g. toothpaste) upon seeing it on the shelf and thus save an extra trip, one might purchase a large quantity of a usual item (e.g. a favorite breakfast cereal) after finding it to be on sale (Nelson 1970). While compulsive, emotionally-charged shopping does occur in some consumers (O'Guinn & Faber 1989), it is a significant minority (Bower 2006).

A more appropriate distinction for the promotion of frugality is that between necessary and unnecessary purchases. But the precise constitution of "need" is not limited to biological imperatives; it is a product of culture, personal taste, habit, social

[2]Indeed, there are people who have succeeded in efforts to buy nothing whatsoever (Lindsay 2004). While these efforts are usually motivated by political or social interests rather than economic ones, they can be very instructive even to those who aren't anti-capitalist.

circumstance, mood, and more (Manning 2000, Shields 1992). Furthermore, exactly where the line between "need" and "desire" falls is malleable. Shopping centers employ carefully designed layouts, architecture, sculpture, music, advertisements, and product arrangements specifically to encourage people to purchase. Shopping centers strive to perpetuate taste cultures of consumption that incorporate their products into lifestyles and identities (Shields 1992). Still, if one were to ask a consumer why he bought a product, he would reply with a rationalization in terms of need (Wood 2005). A persuasive system promoting frugality must thus work to reduce the sphere of possible purchases that "need" encompasses, and to promote alternative explanations to counter rationalizations based on need.

A key insight provided by Dan Ariely and other researchers concerned with human decision making is that even when we know the odds are stacked against us, and we are aware that persuasive techniques are being employed, we can *still* be manipulated. These results all have implications for technologies that are designed to encourage frugal behavior — it becomes critical to employ carefully chosen timing and context for interventions. Simply educating users in advance of a manipulable situation may not be enough to change their behavior; it may be necessary to intervene during a moment of vulnerability.

2.2 The problem of happiness

In order to study and design interventions into spending behavior, it is necessary to understand motivations for spending, which is connected with people's perception of and expectations for happiness derived from the purchases. Intuitively, when we go to buy something, it usually is because we have some impression of the happiness it will provide us (or conversely, the unhappiness it will prevent). Advertisers try to portray users of their products as universally happy, socially well connected, and excited about life because of the products they have, even for products as mundane as chewing gum (Nudd 2008). The persuasive game "Debt Ski" (described in more detail below in 2.3) portrays the player as gaining happiness by obtaining material

possessions. But are these just products of folk psychology? What is the relationship between the pleasure we get out of (or think we will get out of) a purchase and the decision to make the purchase itself? More importantly, what strategy with respect to material acquisition should one take to maximize happiness? The growing field of positive psychology seeks to answer these and other questions related to maximizing "the good life."

In 2001, Martin Seligman and Mihalyi Csikszentmihalyi published "Positive Psychology", a call for research in and justification for a theory of psychology which is not strictly based on pathology, but instead seeks to maximize and further the potential of humans (Seligman & Csikszentmihalyi 2000). Seligman and Csikszentmihalyi sought to produce a science of happiness which could "show what actions lead to well-being.... to help document what kinds of families result in children who flourish, what work settings support the greatest satisfaction among workers, what policies result in the strongest civic engagement, and how people's lives can be the most worth living" (Seligman & Csikszentmihalyi 2000, p 5). Selligman, Csikszentmihalyi and subsequent researchers have drawn heavily on a substantial body of earlier work studying happiness and subjective well-being in order to paint a picture of human virtue that is not without its critics (Christopher et al. 2008).

Researchers attempting to study happiness have encountered great difficulty in pinning the concept down. The meaning of happiness has been variously differentiated as self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life, personal growth, pleasure, emotional well-being, and effective functioning (Shin & Johnson 1978, Ryff 1989). It is through this diversity of understanding of what "happiness" is that we might accept the views of both Albert Einstein ("Happiness never appeared to me as an absolute aim. I am even inclined to compare such moral aims to the ambitions of a pig."(Snow 1967, p 67)) and Aristotle ("Happiness then is the best, noblest, and most pleasant thing in the world..."(Aristotle & Paley 1872)). In his book "Authentic Happiness", Martin Seligman describes a way his conception of positive psychology breaks from our intuition about happiness:

> Imagine a sadomasochist who comes to savor serial killing and derives great pleasure from it. Imagine a hit man who derives enormous gratification from stalking and slaying. Imagine a terrorist who, attached to al-Qaeda, flies a hijacked plane into the World Trade Center. Can these three people be said to have achieved the pleasant life, the good life, and the meaningful life, respectively? The answer is yes." (Seligman 2002, p 303)

Critics of Seligman note that this perspective is a product of a distinctly western individualist viewpoint, as contrasted with collectivist viewpoints that regard *happiness*, *the good life*, and *the meaningful life* as products of relations to other people (Christopher & Hickinbottom 2008, Becker & Marecek 2008).

Despite these problems with the possible meanings of happiness, researchers who study happiness generally do so using rather simplified metrics: they ask people to rate on simple scale how happy they are — either on a numerical scale, or using simple divisions such as "very happy, fairly happy, or not happy" (Frank 2004). This method of study is problematic for many reasons — it leaves interpretations of the meaning of happiness entirely up to the study participant, which makes it vulnerable not only to differences in cultural interpretation (which make worldwide happiness surveys difficult (Ng 1996)), but also to setting, circumstance, and even the context of other questions they may be answering. Study participants who were asked two questions, "How happy are you with life, in general?" and "How often do you normally go on a date?" responded significantly differently when the order of the questions was reversed (Clark & Schober 1992). When asked to assess happiness with particular events, people respond with both a retrospective bias that overestimates the impact of past events on their happiness, and a prospective bias that overestimates the impact of future events on their happiness.(Wilson et al. 2003) In fact, after a period of adjustment, surveyed winners of the lottery and victims of accidents who lost the use of their legs were found to report similar levels of overall happiness (Brickman et al. 1978). To top these challenges in subjective assessment off, the very act of asking people to assess their subjective well-being has been shown to decrease it (Schooler

et al. 2003).

In their critique of positive psychology, John C. Christopher and Robert L. Campbell propose an ontology which can inform questions about happiness, and could work to explain some of the counter-intuitive results which come from asking people how happy they are. Campbell and Christopher propose that people, at first, function with a folk psychology derived from their childhood socialization and experience which explains what things, events, and traits are positive. These understandings exhibit themselves when people engage in consuming activities, react to events uncritically, or act through intuition. But as children mature, they develop a capacity for a "higher level" of knowing, in which they reflect critically and develop their own theories for what constitutes the good life and positive behavior (Christopher & Campbell 2008). Thus, an answer to the question "how happy are you?" could be answered on different levels — from an immediate perception of emotional affect, from a perspective of internalized values, or from a perspective of self-reflection which questions internalized assumptions. These different perspectives might be accessed by tuning the language with which one asks specific questions about happiness (Clark & Schober 1992). However, most existing research still uses simple, ambiguous terms like "happiness", which makes combining or comparing results from different studies difficult.

Despite the wide variety of subjective assessment criteria, the pitfalls in assessment methods, and ill-defined nature of the problem of happiness, positive psychology research presents a compellingly consistent picture regarding the relationship between money, possessions, and happiness. Despite our intuitions to the contrary, the correlation between income and happiness has been thoroughly discredited — once a minimum level of income supporting the basic necessities of life has been reached, more does not result in more happiness (Frank 2004, Kaun 2005, MacFadyen 2003, Pouwels et al. 2008). Material possessions beyond necessities, as well, are negatively correlated with happiness (Boven 2005, Hellevik 2003). Researchers have found that non-material purchases that remove persistent negative influences (such as shortening commute times or decreasing environmental noise) or provide positive non-material

experiences (such as travel, more free time, more social engagement) do result in more happiness (Frank 2004). Giving money to charity is also correlated with increased happiness (Dunn et al. 2008).

Is it right for a researcher to build tools which actively promote particular behaviors in order to increase happiness? Despite the problems with methodology in positive psychological research, can the results described above be used in the design of beneficial applications? The disputed ideal of positive psychology presented by Seligman and Csikszentmihalyi is for a strictly descriptive science, which would "cut across social divides"; they sought to avoid the label of "prescriptive" in their work (Christopher & Hickinbottom 2008). An application which explicitly takes results of positive psychological studies and seeks to persuade people towards particular behaviors for particular ends runs the risk of imposing a particular conception of happiness on another culture, implying its superiority. In the case of individualistic, instrumental value systems, this "has been linked by many psychologists and others to emotional isolation, elevated stress, higher rates of depression, various personality disorders, and other emotional ills in Western society" (Christopher et al. 2008). One should thus be very cautious when exploiting such value-laden research as positive psychology while developing interventions.

2.3 Persuasive technology

Humans have been trying to persuade each other to do particular things forever. It is impossible to have an interaction with another person in which either or both parties attempts to in some way influence the behavior of the other — this is tautologically connected to the notion of *interacting*. For decades, public service announcements, advertisements, and purveyors of both public welfare and private gain have sought to use persuasive media to change people's minds. But in the last two decades, technology has developed which can allow the persuasive medium to become an active intermediary in persuasion which can respond in real time, personalize its message, and interact in much richer and deeper ways than older media like TV, radio, or print

advertisements.

Persuasive technology is a growing area of research, which seeks to produce, categorize, and understand these technologies that persuade people to change their behavior — including everything from systems that promote exercise (Kidd & Brazeal 2007), energy conservation (Mahmud & Dadlani 2007), sober driving, safe sex, community involvement (Fogg 2003), and finance (Persuasive Games, LLC 2009). Stanford researcher B.J. Fogg is largely credited with having started the field through the creation of the Stanford University Persuasive Technology Lab in 1997 (King & Tester 1999). Even as persuasive technologies open up new possibilities for promoting public good, their use introduces new ethical concerns — one must consider not just the already problematized ethics of technological design, but also the ethics of persuasion (Berdichevsky & Neuenschwander 1999). While persuasive technology researchers speak openly and glowingly about the potential of these techniques to improve people's lives, they are less apt to question how the development of these techniques might be used for individual gain to people's detriment as well.

Often, when people imagine persuasive technology, their thoughts turn to shock collars, Pavlovian sugar doses, or other coarse conditioning techniques. While conditioning can be a component of a persuasive technology, it is only one of many techniques, and one which is often deemphasized by researchers, as negative feedback or simplistic rewards can have a strong potential of leading a user to cheat, or to turn off or ignore the persuasive system (Fogg 2003). B.J. Fogg delineates the field of persuasive technology as consisting broadly of technologies which operate as tools, as social actors, or as media (see Figure 2-1). Every technology produces changes in behavior, and every technology promotes certain value systems through its structure and implementation (Feenberg 2002, ch 4). The thing that distinguishes ordinary tools, media, and social applications from persuasive technologies is the intent of the designer — in a persuasive technology, the designer intends for the application to result in a specific behavior change. As an example, Berdichevsky and Neunschwander cite the development of the automobile and highway system as promoting suburban living: "automobiles and highways helped create the American suburbs, but they

Figure 2-1: Classification of persuasive technology proposed by B.J. Fogg 2003, p 25

were not invented with the intent of persuading tens of millions of people to commute to work every day" (Berdichevsky & Neuenschwander 1999). Automobiles and highways, they argue, did not persuade people to form suburbs, assuming the designers of automobiles and highways did not intend for their creations to persuade people to form suburbs. If this had been the designers intent, the cars and highways would be persuasive, even if they had failed to produce suburbs.

Given that the only distinguishing feature between ordinary interactive technology like web browsers or mobile phones and persuasive technology is the intention behind the designer, the ethical considerations of producing persuasive technology collapse into the ethics of producing interactive technology in general. In all technology, unintended consequences are inevitable (Merton 1936), but where the power of technology increases, the magnitude and severity of unintended consequences does as well. Berdichevsky and Neunschwander propose a framework for determining responsibility for these outcomes based on whether they are "reasonably predictable". If an unintended consequence is unethical, but was reasonably predictable, the technology designer is responsible and at fault (Berdichevsky & Neuenschwander 1999). This formulation leaves open to the designers or evaluators of a system whether a consequence was "reasonable", and whether an outcome is "unethical".

The ethical rules for the use of persuasion proposed by Berdichevsky and Neunschwander (1999) as well as B.J. Fogg (1998) suggest that a key in determining whether persuasion is appropriate is if the outcome for stakeholders in the system is

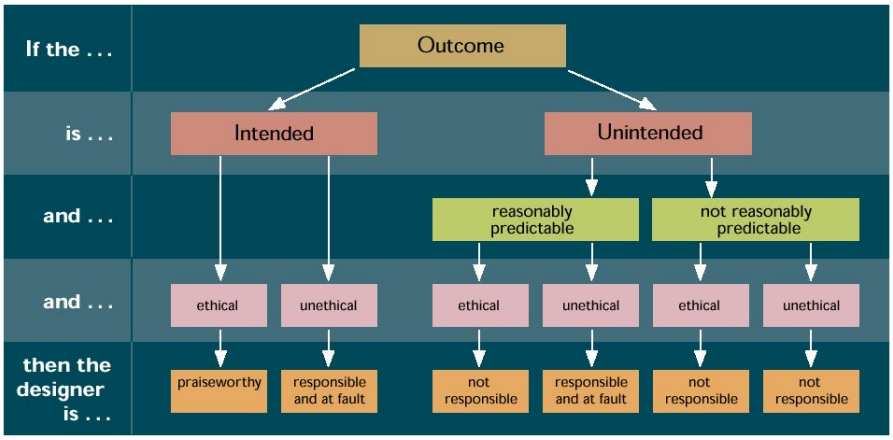


Figure 2-2: Flow-chart for determining ethical responsibility for the outcome of a technology. (Berdichevsky & Neunschwander, 1999)

positive or negative. If a purveyor of a persuasive technology receives a benefit at the expense of a negative impact on the user of the technology, the system may be unethical. Both Fogg (1998) and Berdichevsky and Neunschwander (1999) cite computerized slot machines which persuade players to continue gambling as an ethically questionable persuasive technology.

Many persuasive technologies, including Merry Miser, are elective — the users of the application are free to use the technology to the extent that they find it beneficial, but may discontinue use at any time. However, many choices that people make are in fact against their better long-term self interest; this is the predicate of the design of applications to help someone to quit smoking, to exercise more, or to be more fiscally responsible. Consequently, one cannot rely on the fact that someone willfully uses a technology as a litmus test for its ethicality.

Prior work in persuasive technology

There is a huge body of work which either the designers consider to be persuasive technology, or which researchers in persuasive technology have appropriated under the aegis of persuasive technology. I will describe several examples here that have particular relevance to *Merry Miser* in being related to personal habits, mobility or finance.

QuitKey (formerly *LifeSign*) is a commercial product intended to help people quit smoking. For the first week that users use the product, they are instructed to press a button on the device every time they smoke a cigarette. After the first week, the device instructs them when they are "allowed" to smoke — with gradually increasing intervals between cigarettes. The device has a display which indicates how long before the next authorized smoke, and how long the current cessation program has to go. According to B.J. Fogg's taxonomy, this device operates by *tunneling* — a persuasive technique where a system takes control of decision making and tells you when to act (Fogg 2003). By providing feedback about when the next cigarette is allowed, the system makes it easier to overcome urges to smoke (Stratton 2001, p 118). The form factor of a mobile keychain device which you can carry with you is critical; the device travels with you wherever you have the urge to smoke.

Autom (Kidd & Brazeal 2007) is a personal robotic weight loss coach. It helps people lose weight by providing a social relationship similar to that of a coach. It offers feedback on recent behavior, tracking of exercise and weight over time, and an engaging robotic interface. Autom functions as a persuasive interface on multiple levels — it functions both as a social agent which provides feedback and instruction, and as a measurement tool through logging of weight and exercise.

Nike+iPod (described as a persuasive technology by Wai & Mortensen, 2007) is a combination pedometer and music player, designed to encourage exercise by providing personal monitoring and derived training advice. The system provides motivation by making the process of running more fun, using music and personal statistics as motivators, and improves users' training with salient, personalized advice.

Ubifit is a persuasive mobile application which strives to promote healthy levels of activity (Consolvo et al. 2008). The application consists of a wearable activity sensor that distinguishes from different types of activity (such as running, walking, or strength training), and communicates these classifications to a mobile phone. The phone application displays the activity levels using a metaphorical representation of a garden (see Figure 2-3). As the user exercises, the garden's flowers grow, indicating the extent to which the user has met their fitness goals for the week. As weekly goals

Figure 2-3: Ubifit glanceable display (Consolvo et al., 2008)

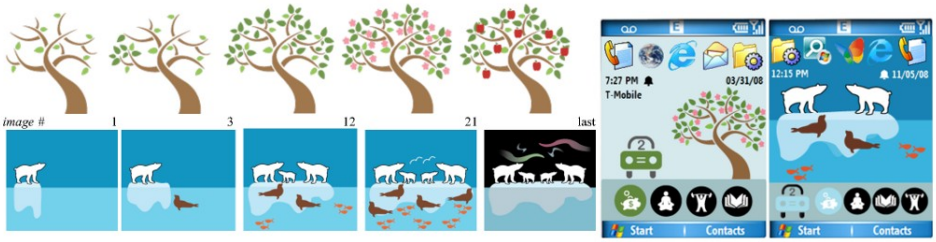


Figure 2-4: Ubigreen glanceable display (Froehlich et al., 2009)

are met, persistent butterflies appear which represent those successes.

Ubigreen is an application developed by the same research lab as Ubifit at the DUB institute at the University of Washington. It applies a similar glanceable display to the problem of promoting green transportation (Froehlich et al. 2009). Ubigreen offers displays of a tree which grows leaves and apples, or of a polar bear with a growing iceberg if the user uses green methods of transportation (see Figure 2.3). The application also strives to promote more immediate benefits of green transportation methods such as exercise (in the case of walking or biking), less stress and an opportunity to do other tasks while commuting (as with public transportation), and also saving money. This balanced approach helps to further promote positive transportation decisions even if an initial fervor of environmental consciousness wears off.

Debt Ski is a computer game which seeks to help players think about the problems of debt and spending developed by *Persuasive Games, LLC* (2009). Players of the game navigate a jet-ski avatar through a virtual world, collecting coins which represent

income, and "necessities" and elective purchases which represent expenditures. The player loses if she or he fails to collect enough necessities, or if she or he accumulates too much debt from spending more than she or he earns. The navigation system is constructed such that it is difficult to avoid elective purchases, and sometimes challenging to collect enough coins or necessities. Periodically, "spending tsunamis" also engulf the player's avatar, resulting in a large one-time expenditure. At the end of each level, if expenditures are higher than income, the players must use credit to pay for the difference. If income exceeds expenditures, the players can choose to pay off the credit card. Failure to meet minimum payments results in increases in interest rates.

Debt Ski provides a metaphorical simulation of the sort of problems one might encounter in real life spending, by requiring certain purchases and making elective purchases hard to avoid. The mechanism for payment of credit cards requires the player to be vigilant about increasing payment rates beyond the minimum payment, which it will do by default. Players accumulate "happiness" points by making elective purchases — a correlation which, in light of research presented above, may be dubious, but is nevertheless likely to be a reinforcement of player's preconceived notions.

2.4 Location based services

With the explosive growth in mobile phone industry in the last 10 years, mobile phones have quickly become the largest pervasive computing platform on Earth, complete with sensors, cameras, and always-on connectivity. Increasingly, phones come equipped with Global Positioning System (GPS) sensors, enabling them to accurately know their location to within a meter, depending on terrain, structures, or other obstructions (Wing et al. 2005). These platforms open up rich new possibilities for context-aware interactive applications.

Among the most widely discussed and anticipated uses of location-aware computing is mobile commerce. Many researchers have discussed or prototyped systems for pushing promotions or coupons to nearby mobile users (Stafford & Gillenson 2003,

Ratsimor et al. 2003, Oh & Xu 2003, Aalto et al. 2004, Randell & Muller 2000). The belief is that by providing cues to users when a shopping center is at hand, they may be more likely to make purchases. In effect, these systems attempt to target advertisements to a particular market segment — those who happen to be near the physical location of a store. This provides the opportunity to transform the older geodemographic maxim of market segmentation, "You are where you live" (Phillips & Curry 2002), into the mobile-commerce enabled "You are where you are". Many researchers have questioned the effect of these systems on users' privacy (Minch 2004, Barkuus et al. 2003); but there has been less study of the effects of these systems on users' well-being. The strong reaction Internet users have had against pop-up advertising (Edwards et al. 2002) highlights the potential pitfalls of mobile advertising.

Location-enabled applications still face significant technical challenges. While the Global Positioning System allows GPS-enabled phones to pinpoint their locations to within a meter where conditions are ideal, conditions are far from ideal in most major cities. Buildings, mountains, and even foliage can provide obstructions that can decrease the accuracy or prevent the function of GPS altogether. In addition, GPS systems place a high load on the limited batteries available to mobile devices, making it potentially impractical to run them continuously.

Prior work in location based services

As with persuasive technologies, there is far more prior work in location based services than can be represented here. The following is a selection of prior work that has particular relevance to *Merry Miser*.

Ringing in the Rain is a mobile application which learns a user's typical routes by tracking locations with a phone's GPS over time, enabling the application to predict where a user is going and how long it will take them to get there. The system then provides relevant environmental information, such as traffic or weather conditions, which might impact the user on the predicted route (Chang & Schmandt 2007).

Risk Meter is a mobile application which aims to improve safety by informing its

user about the incidences of crime in the user's current location. The application can suggest travel routes which go through areas that have seen the least crime, display the levels of crime involving particular types of things (such as laptops or bicycles), and also to communicate with trusted friends or family. The application takes advantage of public databases of crime data, in combination with the user's location and travel history, in order to provide useful information about risk (Chung 2006).

GUIDE is described by its creators as an "intelligent electronic tourist guide" (Cheverst et al. 2000). It functions as a small tablet device which provides extra contextual information about different locations in a city which may be of interest to a tourist. It determines its location by listening for limited range beacons installed at various key locations. Information is displayed on the device using a customized web browser, and is tailored to meet the particular interests, abilities and history of each visitor.

ShopSavvy (*ShopSavvy* 2008) is a mobile application which allows users to compare products, write and view ratings and reviews, and search inventories of nearby stores. Users can identify products by scanning barcodes, and can create wish lists, track purchases, and receive alerts when prices for particular products drop below user-specified thresholds. ShopSavvy functions as a tool to help users do in-situ comparison shopping.

Relevant mobile and financial applications

While not describable as location based or context-sensitive, there are several banking and finance related mobile applications that have relevance to Merry Miser. These fall into two rough categories: those which provide basic financial information, and those which provide basic financial calculations.

Financial information applications are usually tied to non-mobile services, such as banks or bank account aggregators. Bank of America, Intuit, Wesabe, Mint,[3]

[3]The following are websites for various mobile account information providers: http://mobilebanking.bankofamerica.com/, http://quicken.intuit.com/quicken-online/download-iphone-application-software.jsp, https://www.wesabe.com/page/mobile, http://www.mint.com/features/iphone/.

and other financial institutions and aggregators provide access to users' account and transaction information through a mobile application, including graphs and charts of transactions, and an overview of budgets and spending categories.

Basic financial calculator applications include tip calculators, stock tickers, ATM locators, checkbook balancing and registry applications, and basic budget calculators.[4]

[4] At the time of writing, the following websites have lists of finance applications: http://www.mint.com/blog/finance-core/10-iphone-finance-apps-that-count/, http://mashable.com/2009/02/02/free-financial-iphone-apps/, http://iphoneapplicationlist.com/category/businessfinance/

Chapter 3

Merry Miser

This chapter describes the design, implementation, and evaluation of Merry Miser. The working application was tested with four users over a period of four weeks.

3.1 Concept

Merry Miser functions by presenting presuasive, informational, and compelling interventions that promote frugality at a time and place when a user is in a position to make a purchase. The interventions consist of:

- A glanceable display which shows the user's financial status and progress towards saving goals.
- A location-aware notifier that pops up interventions when the user is near an opportunity to shop. Information pertinent to the user's location is displayed, such as the amount the user has spent at this store in the past.
- Prompts for assessment of purchases, and predictions of future assessments, after a purchase.
- A mechanism whereby the user can make contracts with themselves, specifying maximum spending targets over specific periods of time.

- Representation of money in different metaphorical "currencies" (such as hours, meals for the homeless, or any other denomination meaningful to the user).
- A representational reward for charitable spending.

The application presents different interventions at different times depending on what is pertinent, but all of the elements of the application are also accessible at any time by navigating the user interface.

3.2 Technical design

3.2.1 Data flow

In order to ease the possibility of functioning with multiple different mobile phone architectures, Merry Miser was designed using a thin client model. A native phone application handles GPS tracking and proximity alerts, but accesses the main Merry Miser user interface entirely through its web browser. In order to avoid having to write translators for all the various banks and credit card providers that users might have accounts with, Merry Miser uses the third party account aggregator Wesabe[1]. It was necessary to associate additional data that is not present in the Wesabe database — such as the location of merchants, and users' assessments of transactions. Thus Wesabe's data is mirrored in the server application's database. The phone application does not store any data, other than a current list of merchants which is periodically updated by querying the server. See figure 3-1 for an overview of the application structure.

The use of this architecture has advantages as well as tradeoffs. Decoupling the location application which runs on the phone from the web application that provides the main user interface allows the application to more easily accommodate multiple phone architectures, as well as computer web browsers. The data is also more secure should a phone be lost. Storing transaction data on a server, however, poses privacy

[1]Wesabe: http://wesabe.com. Other aggregators exist such as http://buxfer.com and http://quicken.com; Wesabe was chosen because of its public API.

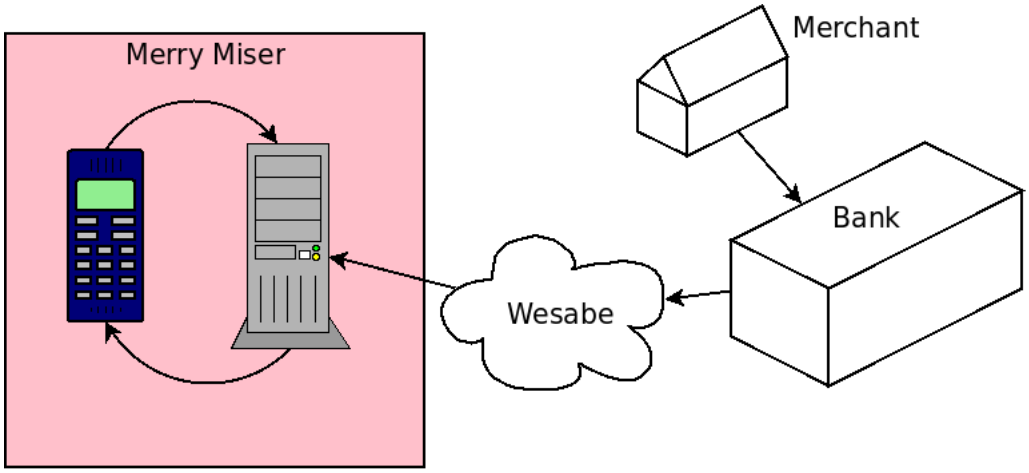


Figure 3-1: Application structure for Merry Miser. Transaction data originates at a merchant, is recorded by the bank, and read by Wesabe. Merry Miser periodically mirrors the transaction data from Wesabe, in order to associate it with other information (such as merchant locations and assessments). The phone application receives transmits all information to and from the server via HTTP requests.

and security risks, as the user is not in control of the data at all times. It also makes the application depend on running infrastructure beyond the handset, and increases latency in the user interface. As described in the evaluation section, users found the web-based nature of the interface to be beneficial, as data entry was easier on a computer than on the limited input hardware of the phones. No user reported latency as being a detriment to the application's function.

3.2.2 Server architecture

Merry Miser was written using the Django[2] web framework (with its built-in Geographical Information System (GIS) extensions, Geodjango[3]). Geodjango operates with the PostgreSQL relational database system[4], and the PostGIS geographic database extensions[5], which allows allows for efficient geographic database queries (such as finding all records within a specified distance of a point). The Django web

[2] http://djangoproject.com
[3] http://geodjango.org
[4] http://www.postgresql.org
[5] http://postgis.refractions.net/

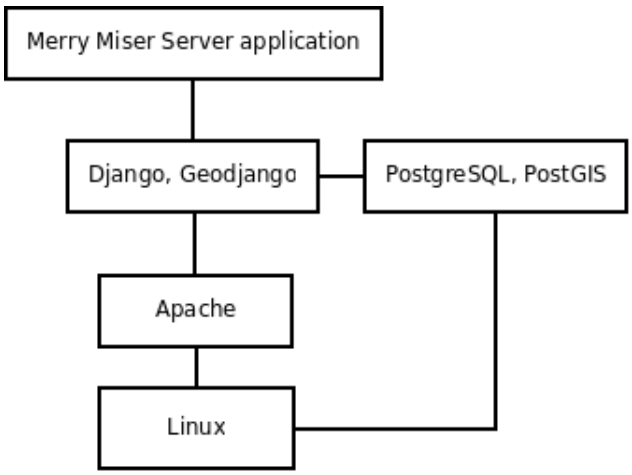


Figure 3-2: Diagram of the server application stack.

framework was connected to an Apache web server[6] with a WSGI[7] interface, using mod_wsgi[8]. The whole stack runs on a Linux server. See figure 3-2.

3.2.3 Client architecture

The phone application consisted primarily of a standards-compliant web browser (able to properly render CSS and execute javascript) running on the mobile phone. In order to access location information, it is necessary to interact with phone hardware such as the GPS unit, which requires a native application. For this prototype and user test, the client application is implemented for Android[9] based phones. The native application serves to query the GPS unit for the current location, to notify the user when an intervention is desired, and to launch the web browser to display the main interface. The application stores a list of locations which should trigger an intervention, which it periodically refreshes through an HTTP request to the Merry Miser server application.

To combat the problems with latency, Merry Miser uses Google Gears[10], a proprietary extension for web browsers which allows the browser to locally store files.

[6] http://httpd.apache.org
[7] Web Server Gateway Interface, http://wsgi.org
[8] http://modwsgi.org
[9] http://android.com
[10] http://gears.google.com

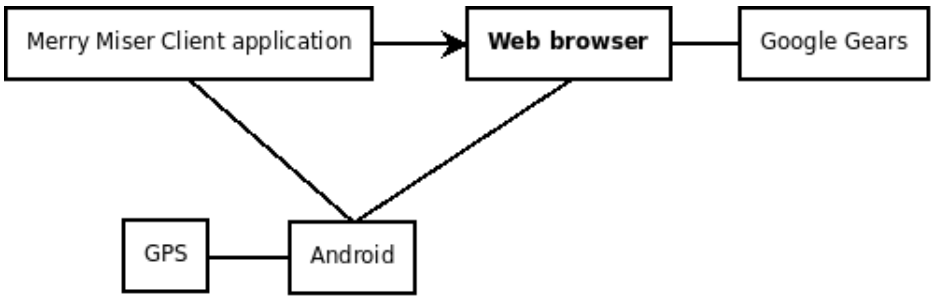


Figure 3-3: Diagram of the client application stack.

Thus, all static media images, javascript files, and style sheets could be locally stored in the phone, reducing the bandwidth required for visiting any of the application's pages to approximately 2KB, with a single HTTP request, instead of 50KB with 16 or more HTTP requests for all the various images and supporting files. This resulted in a substantially more responsive interface. Google Gears is supported by all of Google's web browser products (including the default browser on Android phones), and can be supported by installing extensions on other browsers such as IE Mobile, Opera Mobile, Firefox, and Safari. Where a browser does not support Google Gears, the application functions identically, but without the speed improvements to the user interface.

3.3 Technical challenges

In any software project, a majority of time is spent solving a minority of difficult problems. Here I will describe these more difficult problems and how they were addressed.

3.3.1 Difficulties with GPS

GPS units are notoriously difficult to use effectively for location based work due to their high battery consumption, the length of time required to get an accurate fix, and the potential noisiness of their results. The Android SDK offers two different strategies for receiving location information from the GPS: "proximity alerts" and "location updates". An application using proximity alerts receives a notifica-

tion when the phone is within a specified distance of a registered location. Android handles all the implementation details of determining how quickly to poll the GPS hardware for new locations, and how to handle low-power sleep states when the phone is not actively being used. With the location update strategy, Android notifies your application every time a new location is detected. Application developers can specify a "guideline" for how frequently this should occur, but Android does not guarantee that this frequency will be honored, and handles the implementation details of deciding when to poll. The developer must handle details about sleep states.

I found both of these strategies to be unacceptable for a location sensitive application that was intended to be always running. The proximity alert strategy consumed battery far too quickly (I found that the battery would last only three to four hours while the application was running, even when the phone was not in use, in contrast to more than 24 idle hours when the application was not running). The indeterminacy of update frequencies with the location update strategy made it difficult to properly implement an efficient proximity alert mechanism. Android would tend to poll the GPS far more frequently than requested, resulting in fast battery drain.

To address these issues, I implemented a proximity alert system using the location update strategy. Rather than relying on the unpredictable frequencies that resulted from requesting that Android provide location updates at slower rates, I implemented a system that always requested updates at the fastest rate available, but then disabled location updates until the next polling period. The polling period was defined as half the estimated time it would take to get to the closest location. If a new location is not received within a specified period of time, the GPS is turned off for a longer timeout interval before being re-enabled. Thus, the battery is not unnecessarily drained when the user is in a place with poor GPS reception, such as inside a building.

Since we only know a latitude and longitude for each pertinent location, and not a geometric shape of the structure, it is necessary to set a proximity radius that is larger than the building to contain it all. As we can't rely on GPS functionality indoors, so the radius must be enough larger than the building that it captures someone who approaches the building and then disappears inside. Thus, we must distinguish

```
# Function called when a new GPS reading is available.
def receive_update(location):
    # Ignore any GPS results that are below a threshold accuracy
    if location.accuracy < minimum_accuracy:
        return

    # Since we have a new reading, we are not in a timeout condition.
    stop_timeout_timer()

    # Find the closest location.
    closest_location = null
    for target in list_of_targets:
        if target is closer than closest_location:
            closest_location = target

    if distance to closest_location < target_radius:
        if location != current_location:
            current_location = location
            # Start a timer to make sure we aren't just passing through
            start_proximity_timer()

    # Estimate the time it will take to get there
    polling_interval = (distance to closest_location) / (last_speed * 2)

    disable_gps()
    wait( polling_interval )
    enable_gps()
    start_timeout_timer()

# Function called when the proximity timer has finished.
def proximity_timer_finished():
    if last_known_location == current_location:
        alert_user()

# Called when the timeout timer finishes, indicating we have timed out
def timeout_timer_finished():
    disable_gps()
    wait( timeout_interval )
    enable_gps()
    start_timeout_timer()
```

Figure 3-4: Pseudocode listing for algorithm to poll GPS.

between users who are simply walking past a building, and those who are stopping in. This is accomplished using a simple timer — if the last known location is one inside the radius for a period of time, they are assumed to be inside that location.

Pseudocode describing this algorithm is listed in figure 3-4.

3.3.2 Identifying transactions

In order to minimize the amount of manual data entry required of its users, Merry Miser attempts to automatically identify merchants based on the memo string from credit card statements, and to subsequently determine their locations. However, the information available from credit and bank card statements (and by extension, from aggregators like Wesabe) is very limited. Anyone who has spent time reviewing credit card statements is probably familiar with the form the transaction records take — a garbled abbreviation of the store name, a city and state which may also be abbreviated (or replaced with a zip code), possibly a date, and some additional numbers which are usually not meaningful to an end-user. Here are some examples:(the numbers have been changed for privacy protection):

```
POS 0123 4567 012345 SOU THE HOME DEPOT 562 BOSTON MA
03-12-09 HARVARD BKSTR 90200015 CAMBRIDGE MA auth# 12345
POS 5432 1012 543210 BROADWAY BICYCLE SCHOO 02139 MA
```

The strings represent purchases at "Home Depot", "Harvard Bookstore", and "Broadway Bicycle School", respectively. While there is some consistency in the listing format, the consistency is inadequate to easily find an automatic means of locating the business in question. Even within franchises, the choice of abbreviation varies considerably, making it difficult to pin down a merchant. Here are 4 different memo strings taken from hardware stores, all of which are True Value franchises. The phrase "True Value Hardware" is variously abbreviated as "TVHDWE", "TRUE VA", "TRUE VALUE", and "TRUE VALUE HD":

```
POS 0123 4321 456789 SY8 ECONOMY TRUE VA262 BOSTON MA
```

```
07-29-08 YUMONT TVHDWE JAMAICA PLAINMA auth# 54321
07-18-08 TRUE VALUE GUNNISON CO auth# 23456
04-26-08 HAMILTON TRUE VALUE HD DORCHESTER MA auth# 34567
```

Despite this inconsistency, humans can usually parse the listings, especially for their own purchases. To parse this algorithmically would be extremely difficult, and would require a very large training set of possible stores and memo strings. A much simpler implementation is to require users to identify the transactions. However, people will not tend to know either street addresses or latitudes and longitudes of the stores they go to, so it is necessary to determine their locations some other way. Once a user has identified the location of a store, we can share this association with other users, so that any store location only needs to be entered once by one user.

Transaction Geolocating Server

To accomplish this task, Merry Miser uses a separate server application: a transaction geolocation server. This was implemented using a REST[11] interface developed with the Django web framework. Clients (such as the main Merry Miser server application) make requests to this server in order to find merchants that are near a particular location, as well as to find merchants associated with particular transaction memo strings. For a full description of the REST API for the transaction geocoding server, see appendix A.

Transaction memo strings often contain unique numbers or dates that are different per transaction. It is necessary to filter these numbers out in order to properly associate different memo strings with the same merchant. By experimentation, the following regular expressions were found to effectively filter the results[12]:

```
(\d{2}\-\d{2}\-\d{2}) # filter out date strings
(auth# \d+)           # filter out auth tokens
```

[11] Representational State Transfer, see:
http://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm

[12] These regular expressions are expressed in Python; matched strings are removed. Documentation of the Python regular expression syntax can be found here: http://docs.python.org/library/re.html

```
(POS \d+ \d+ \d+ \d+) # filter out point of sale tokens
(\d{4} \d{4} \d{6})   # filter out ATM tokens
```

Since we rely on users to provide associations between merchants and locations, we must allow for the possibility that users report inaccurate associations. Thus, the database allows multiple associations between memo strings and merchants. Each time a user reports a merchant and memo string as being associated, this adds a "vote" to that association. When querying for merchants that match a particular memo string, the results are returned ordered by the number of votes each association has.

3.4 User interface

The goal of the Merry Miser application is to persuade users to think more about their spending and what they get out of it, and to save more. This goal shares similarities to prior work such as Ubigreen and UbiFit (see section 2.3), applications which persuade people to drive less and exercise more, respectively. However, the good behavior these applications promote is incrementally additive: one gets incrementally better improvements by driving one fewer day, or by exercising a little more. This makes it easy to create a user interface which incrementally provides rewards, and never takes the rewards away — any amount of exercise will improve one's progress. With saving, however, the behavior we are trying to promote is inaction — we aim instead to prevent spending, a behavior which is incrementally *subtractive*. Every small purchase is a slight backwards step away from one's saving goals. It is generally not practical to suggest that users should find ways to earn extra money incrementally; for most people with regular employment, income tends to come in larger sums infrequently.

This presents a challenge, as research in persuasive technology has widely shown that users prefer and respond better to positive reinforcement than negative reinforcement (Fogg 2003, Froehlich et al. 2009, Consolvo et al. 2008). It is important not to provide rewards which are then taken away, or to scold the user excessively. The user interface described below was designed with the intent of addressing these

concerns, and providing an easy glanceable display that gives an honest perspective on the user's financial status, but with minimal negative reinforcement.

3.4.1 Home screen

The main screen of Merry Miser is intended to provide a glanceable, compelling, and interpretive perspective into the general state of the user's finances. The home screen is entirely graphical; the different images on the screen are active, clickable components which give access to various parts of the application. The components of the interface are as follows (see figure 3-5):

- Apples: the user's goals. Accesses UI to edit and view goals and progress.
- Stick figure: the user. Accesses list of transactions and assessments.
- Money bag: the user's income. Accesses report on income rates.
- List on tree: Accesses list of merchants the user does business with, as well as contracts the user may set to spend certain amounts (see section 3.4.5).
- Gear: settings for the application.
- Log: an experience log, used for the user evaluation. Users were asked to frequently log their experience with the application (see section 3.5 for more on the user evaluation).

As the user earns money, the money bag grows, pulling the user closer to the apples which represent the goals. As the user spends money, the money bag shrinks, and the user drops farther away from the goals. The scaling of the money bag and distance from the goals are dynamically tied to the goals that the user has entered — if the goals are modest in relation to the user's income, she or he will progress to the goals much more quickly. Reaching the apples indicates that there is enough money in the user's accounts to fulfill the goals.

Figure 3-5: Main home screen interface for Merry Miser

If the user's spending falls behind, or if credit card usage results in a negative balance, a ball and chain grows at the user's feet, representing an impediment toward rising up to the goals.

Charity

Even though charitable expenses are likely to be something which works against one's savings goals, they are also widely believed to promote happiness (Dunn et al. 2008, Frank 2004, Konow & Earley 2008). To help promote charity, the Merry Miser interface adds elements to beautify the main interface if the user makes charitable purchases — including adding leaves to the tree, flowers, and a starry background.

3.4.2 Transaction categorization and assessment

When a new transaction appears on a user's bank statement, it is necessary to categorize the transaction and to identify the merchant and it's location. If the transaction comes from a vendor that has not yet been associated with the memo string, it is necessary to ask the user to identify the merchant. To make this as easy and familiar

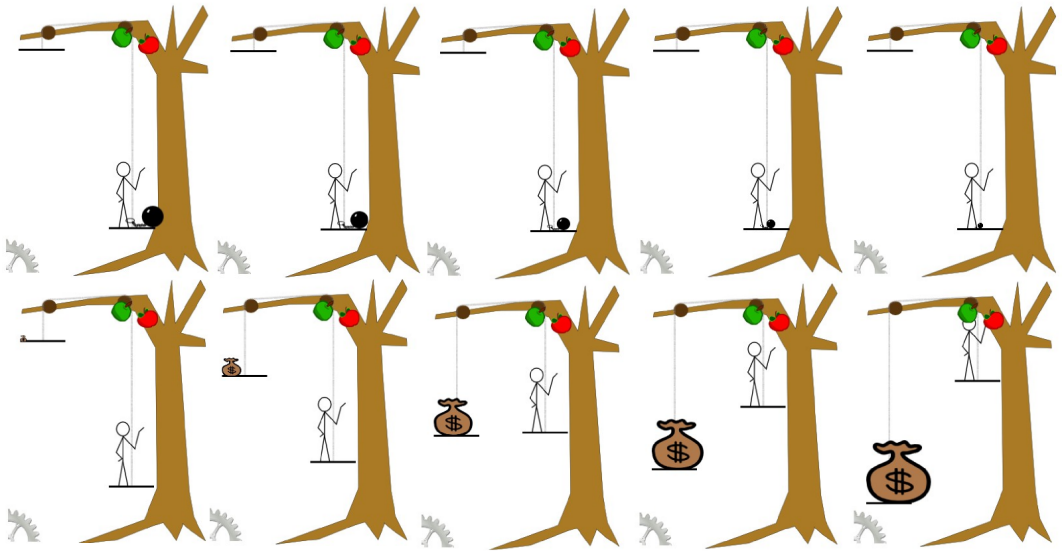


Figure 3-6: Progression of the user interface as the user earns money. The top left indicates a state of heavy debt, and the bottom right indicates a state of having enough to reach the goals.

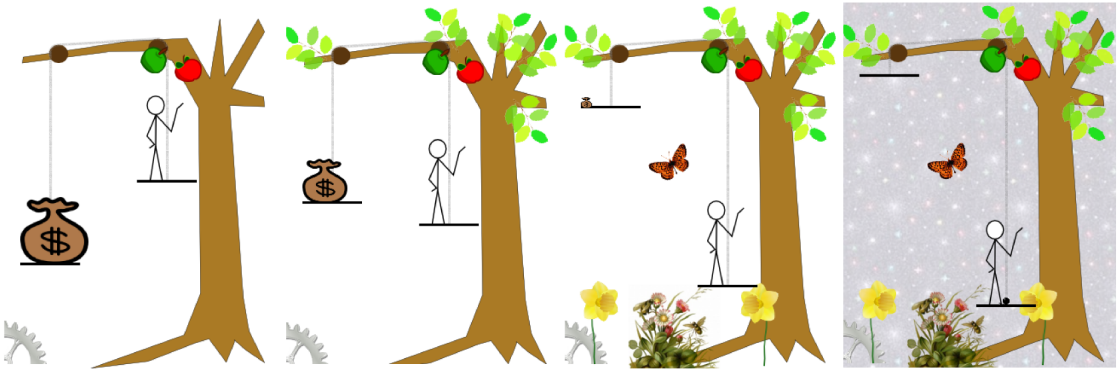


Figure 3-7: Home screen displaying different proportions of charitable expenditure — as the percentage of one's expenditures that are charitable increases, the interface grows more decorated.

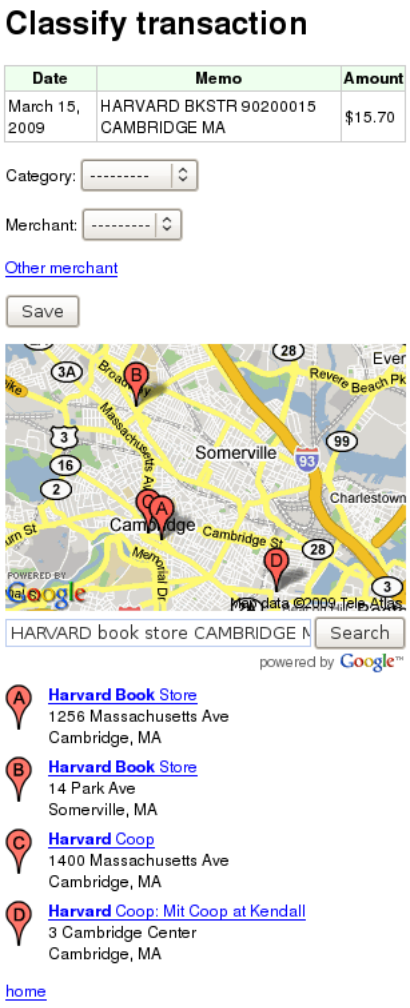


Figure 3-8: Interface for classifying and identifying merchants.

a process as possible, Merry Miser uses the Google Local Search API[13]. A version of the memo string with as much extraneous information as possible is put into the search box by default; a user can subsequently edit the string to produce a better search (see figure 3-8 for the classification interface).

The categories into which purchases can be classified were intentionally left as simple as possible — there are only four categories: income, transfers, charity, and spending (a fifth category, "ignore", removes the transaction from consideration by the application). Income is automatically detected (it always has a positive balance), as are standard transfers. However, users are given the ability to categorize other

[13] http://code.google.com/apis/ajaxsearch/local.html

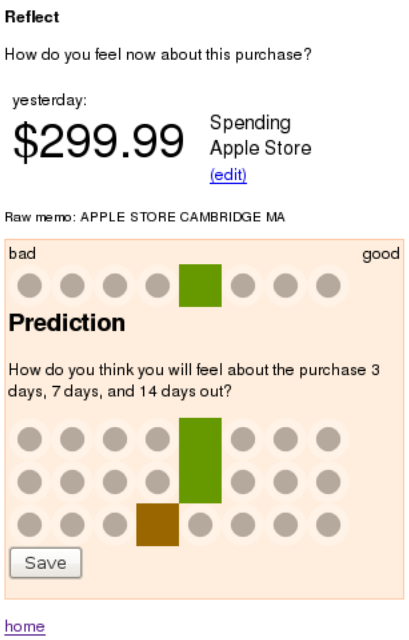


Figure 3-9: User interface for assessing a transaction for the first time. Responses fade in color from red to green for "bad" to "good".

transactions as transfers for expenditures like credit card payments (transfers are not counted toward the account balance).

Assessment

Users are asked to assess each transaction when it first appears, and again three, seven, and 14 days later. On the first assessment, they are also asked to predict how they will feel on the subsequent days. The assessment scale is an arbitrary 8-point scale between "bad" and "good" (see figure 3-9 for the assessment screen). These assessments serve several purposes — to remind the user of the fact that they spent money, to ask them to think about whether the purchase was good for them, and to be more aware of prospective biases on assessments of happiness. Given the uncontrolled nature of the environment in which the user is asked the questions, it is highly likely that the responses will be effected by external influences, and not accurately portray the user's feelings toward the purchase. However, the goal is served if it only makes the user stop to think about their spending.

Responses to these assessments are organized in a tabular form, allowing the user to, at a glance, see how they have responded to all transactions over the history of the last month or more (see figure 3-10 for a tabular detail of all responses to transactions).

3.4.3 Currencies

Merry Miser gives the user the option to select currencies other than standard currencies such as dollars. For example, users could specify a currency called "Hours" which represents the amount of money they earn in an hour of work, or "Meals for the Homeless" which represents the cost of a meal for the homeless. Representing money in this way can change the way one perceives a sum of money. If an iPod costs 250 meals for the homeless, it changes the way one perceives the expenditure. When a user selects a currency, it is used for all displays of figures except for new purchases that need categorization (these are left in the default monetary currency in order to make it easier to identify the transaction). See figure 3-10.

3.4.4 Merchant information

When a user goes to a store, or when they click on information about a merchant, they are presented with a screen that displays details about the user's spending and assessment history at that store (see figure 3-11). This includes details about the spending totals for the last week and month, the average cost of a purchase, and amount still needed to fulfill one's goals. In addition, the screen contains a randomly selected quote from a famous writer related to spending and happiness (see appendix B for a complete list of quotes).

3.4.5 Contracts

Merry Miser provides users with the option to set contracts for themselves — promises that they will spend less than a specified amount over a specified period of time. For example, a user might want to spend less than $100 over a weekend. By establishing

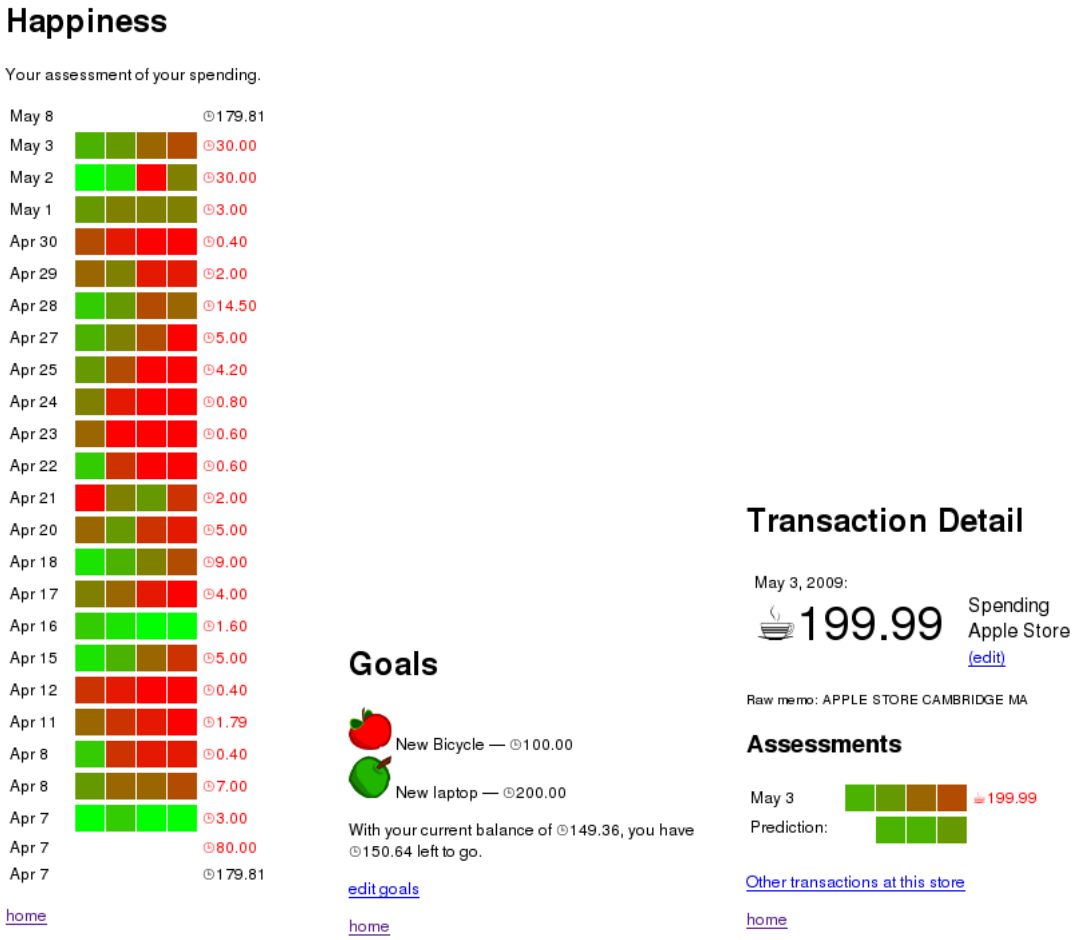


Figure 3-10: Assessment list and goals using the metaphorical currency "hours", and a transaction detail showing the currency "Meals for the homeless". Responses fade in color between green for "good" and red for "bad".

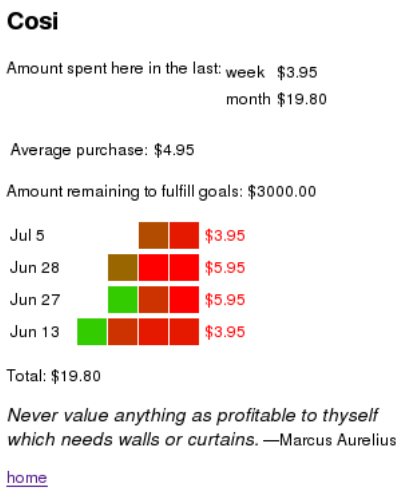


Figure 3-11: Details of a merchant, displayed when the user arrives at the merchant or selects it from a list.

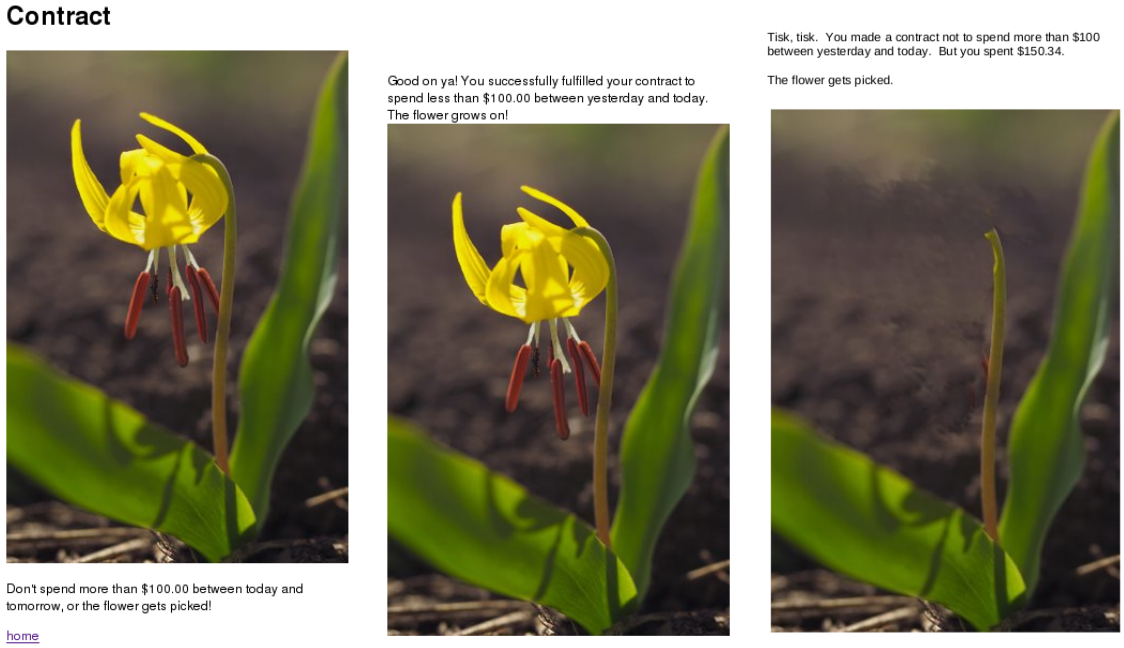
the contract and explicitly setting a target, a user might be more motivated to stick to it and remain frugal. The consequences for failing to fulfill a contract are simply that the user will be shown a mildly unpleasant image — for example, an image of a flower that has been decapitated. See figure 3-12 for an example contract.

3.4.6 Data deletion

To protect user's privacy, the Merry Miser web interface includes a mechanism for deleting any piece of information that the application has about the user. This includes all transactions, assessments, and account information. For the user evaluation, the application maintained a record when this feature was used, but otherwise, the deleted information was removed from the system entirely.

3.5 Evaluation

Merry Miser was evaluated over a period of four weeks by four users (one of whom used the application on a non-Android phone, and thus evaluated the application without the GPS notification feature). Of those using the GPS enabled application, one experienced technical problems which prevented the GPS function from working,



(a) Confirmation of a new contract

(b) A successful contract

(c) A failed contract

Figure 3-12: User interface for contracts.

and thus only two users evaluated the full application. The purpose of this pilot evaluation was to provide a test of the technology, and to gain some subjective insight into the design and function of the application. The users set up accounts with the Wesabe bank aggregator service, and were given mobile phones running the application. During the course of the evaluation, users were asked to log their experience using a built-in logging interface, and were compensated in proportion to the number of log entries they left ($0.50 per logged experience, regardless of length or content). At the end of the user test, the users were interviewed about their experiences during the study, and specifically about each of the main components of the application. The following subsections describe the users' feedback about each component.

The users were recruited through email advertisements and meetings at the MIT Media Lab. They consisted of one male graduate student, one male administrative assistant, one female graduate student, and one male non-student technology researcher, none of whom had prior relationships beyond acquaintance with the administrators of the study.

3.5.1 The Wesabe interface and transaction updating

Every user in the study had some difficulty with the Wesabe setup and the uploading of transaction data. One user primarily shopped using cash, and thus set up a "cash account" on Wesabe; these transactions were not properly downloaded by Merry Miser. One user attempted to use the "automatic uploader" feature on Wesabe which stores bank account credentials on Wesabe's site, allowing the update of transactions without using an additional desktop application or web browser plugin, but found that the transactions would only update when the user logged into Wesabe[14]

Users of the "firefox uploader", a browser extension that Wesabe provides to allow users to script the process of downloading a statement from their financial institution and uploading it to Wesabe, found the interface to be onerous and brittle. Changes to the bank website (including new interstitial ads) would break the script, and javascript confirmation boxes were not properly recorded by the script recorder.

All of the test users found the transaction updating provided by Wesabe to require attention and hand-holding to function properly; each had problems with Wesabe. An improved means of getting bank transactions that is truly automatic would be a significant improvement for the function of the application. Each user expressed a preference for some system which would automatically download every transaction as soon after it is made as possible, without requiring any extra effort on the part of the user. Future research might explore additional aggregator services as public APIs become available, or partnerships with financial institutions to make data more readily accessible.

3.5.2 The main graphical interface

The main graphical interface of Merry Miser is a collection of icon elements that form an image of a tree, with a stick figure representing the user, apples in the tree representing goals, a money bag representing savings, and more (see section

[14]This is probably due to Wesabe's security model, which separates personally identifiable information from transactions using a hash constructed from the user's login credentials (Hedlund & Greenlee 2007). This likely makes it so that Wesabe cannot update a user's transactions using the automatic uploader unless the user has an active web session on Wesabe.

3.4.1). The primary mechanism of the interface is the balance between the stick figure represnting the user, and the money bag which pulls the user toward the goals.

One of the goals in the design of this interface was to make it as simple and intuitive as possible, to reduce the complexity of financial accounts to two variables: the amount of money one has, and goals for which one is saving. While they described the interface as intuitive and comprehensible (and one user described the interface as "cute"), all of the users found the interface to be insufficient to capture what they expected regarding their accounts. One user found the interface inadequate in covering his existing savings. The user had enough in savings to cover the cost of goals for which he was saving, but that savings was earmarked for other purposes (such as retirement savings or kept for emergencies). It did not seem intuitive to enter target values for retirement or emergency savings as "goals" to which one was savings. The user believed that having more fine-grained control over the classification of particular savings accounts (such as setting aside some savings as off-limits) would improve the interface. While a user could specify target values for emergency and retirement savings as goals, these long term balances would reduce the dynamic range of the visualization, as one would never be far from shorter-term goals.

Another user found that the ball-and-chain visualization for debt was a persistently negative and frightening image. While he did find this to be a strong motivator toward spending less, it could be self-defeating by decreasing people's motivation to use the interface. The user felt that if there were a way to simulate the process of lifting out of debt, this might provide a more positive motivation. Another user commented that the abstract metaphorical nature of the diagram might benefit from an easy indication of the actual balance in one's accounts at any point in time, relieving them from checking with the financial institution or Wesabe to determine their current balance.

A full evaluation of the effectiveness of the visualization was limited by the length of time of the study. As mentioned in the description of the interface above (section 3.4.1), the design of a persistent visualization of savings is made difficult by the way that money arrives in lump-sums, and then trickles out slowly. The sudden nature

of this change led one user to believe that the interface might be broken when a paycheck resulted in the sudden appearance of the money bag icon, but then changed very little for a period of time.

All of the users found entering information and using the interface using a web browser on a computer to be easier than using the interface on the phone. Some particular design improvements could help this, such as moving controls at the bottom of the screen away from Android's browser's zooming controls, which sometimes resulted in conflicts.

3.5.3 Prompts for assessment

The users had positive evaluations of the process of assessing transactions. One user commented that it seemed like a key component of the application, that it was very helpful in getting the user to think about their spending. The users all responded negatively when asked if the process of repeatedly assessing each transaction over a period of 14 days was annoying or overly time consuming. The application was designed so that every time one visited it, if there were transactions that required assessment, they would be displayed before showing the rest of the interface. One user suggested that he would have preferred to be able to defer a response to these questions in order to access the other features of the application more easily.

One user found that the assessments of transactions were more effective at evoking thoughts about spending in general than evaluation of the particular transaction in question. The fact that prompts for assessment for past transactions would come up when he visited a store seemed an effective way of framing an experience at that store for frugality.

3.5.4 GPS function and proximity notifier

The GPS function of Merry Miser was supposed to push a notification to the user when they were in a store. The functionality was neither sufficiently sensitive, nor sufficiently selective. Users reported that in some circumstances, notifications would

come up when they were walking by a store, even if they weren't going inside, while in other circumstances, no notification would arise when entering a store which had previously been logged with the application. Two users reported that they were unable to find some stores using the google search interface, and thus were unable to pinpoint a location for the stores.

This difficulty with GPS may not be easily solvable without a complete redesign in the proximity notification component of the application. There are several problems which make this difficult. The latitude and longitude coordinates supplied by point of interest servers such as Google Local Search are not highly accurate — sometimes the locations are in the center of the store, sometimes on the street in front, and sometimes off by tens of meters. Even if they were perfect, however, these results only supply a point, where the buildings in question extend in three dimensions. This makes it necessary for the radii around stores to be made very large, in order to cover both the area inside the store, and the area outside of it where one would walk before entering. As the GPS signal sometimes (but not always) disappears when entering a building, it is only possible to determine that one is inside the building if they have not exited the location's radius within a certain period of time. However, this can also be triggered by entering other dead spots in GPS coverage (such as some streets with tall buildings) or if one is not moving quickly enough. A different approach would likely be necessary to substantially improve the accuracy of detecting when one enters a store.

One user, for whom the GPS function never worked properly, reported that even though it didn't work, just carrying the application with the expectation of what it was supposed to do altered the way she thought about spending. While this effect would probably wear out or lose its potency if the application never worked reliably, it does speak to the power of the idea behind the application. Another user reported that when he first saw a location from a nearby chain store, he feared that the chain store was engaging in some location-based "spamming", which made him angry. But when he realized it was from the Merry Miser application, he felt much better about it.

3.5.5 "Make a contract"

Merry Miser provides a feature to let users make contracts with themselves, promising not to spend more than a specified amount over a specified period of time. Two users tried using this feature; both stayed within the contract in that time, and thus did not experience a failed contract image. One user believed that it did influence the way he thought about spending during that time; the other user reported that no desire to spend had come up during that period anyway. Both believed that this could be a useful feature in different situations, particularly where specific events come up such as holidays or vacations.

3.5.6 Metaphorical currencies

Merry Miser provides a feature to represent money in the application via metaphorical currencies such as "hours", "meals for the homeless", or any other quantity for which the user can provide a conversion into dollars. None of the users tried using this feature. One user reported confusion, believing it to be a feature about different national currencies rather than different representations of the same currency. The other users believed that it might be useful, but they had simply forgotten the feature was there.

3.5.7 Display changes with charitable spending

Merry Miser provides a feature to promote charitable spending by adding pleasing detail to the main visualization if different percentages of income are categorized as charitable. Only one user logged a transaction as charitable during the course of the study (two others commented that they wished they had, that it would have been nice to see the feature in action). The user commented that the opportunity to explicitly categorize a transaction as charitable, and the corresponding appearance of leaves on the tree in the main visualization, made him feel very good about his charitable contributions, and made him feel an incentive to make more charitable contributions.

3.6 Next steps: improving Merry Miser

In my opinion, there are three primary areas in which Merry Miser could improve: making the infrastructure on which the application relies more robust, improving the way the application handles budget, and paring down the featureset to a minimal set of features known to be effective.

Merry Miser relies on an overly brittle infrastructure. The acquisition of transaction data through Wesabe does not work seamlessly and automatically enough. The process of converting transactions to locations is still overly difficult, and the detection of locations is not reliable enough. Simplifying this infrastructure by addressing each component and making it more reliable would go a long way to improving the functionality of the application.

The simplistic budgeting model used by Merry Miser (lumping all accounts together and considering only three financial goals) is inadequate. The application would benefit greatly from a carefully redesigned mechanism for establishing different types of goals and accounts. A possible model for this would be to subdivide savings into different categories — including long term goals, short-term goals, money that is off-limits or for emergency purposes, and also taking into account expected expenses such as rent, mortgage, or car payments. While raising the ceiling on the budgeting capabilities, it would be essential to maintain the very low barrier to entry, ensuring that an unsophistocated user or one who only wishes to casually use the application can still benefit from its use. Careful categorization and budget creation takes a substantial amount of time, and may pose diminishing returns as it becomes finer grained. However, every user of Merry Miser found that the simplistic categorization was inadequate in representing the users' perspectives on their budgets; a better middle ground should be found.

While Merry Miser does contain a rich set of features, all of which have a potential to be effective in helping people to be more aware of their financial activity and its relation to their livelihoods, it would be invaluable to seek to tease these different components apart, to better determine which are the most effective. It would be use-

ful to compare each feature in isolation to determine how effective it is in promoting reflection on spending and frugality, and to use these results to simplify the application, reducing it to a more compact and effective core. Questions to be answered in assessing the features of the application include:

- Is the use of location important? Could the application be as effective without ever knowing where the user is? If the application can be shown to be effective without location, this dramatically simplifies the implementation, which could make it far more robust.

- Is it important to use personalized transaction data? A user could be presented with general, non-personalized information. General narratives could be combined with location context to provide a financially-oriented "tour" of sorts. Tests could be conducted in which different sets of users are provided with general narratives or personalized information, comparing the effect.

- How effective is the assessment of transactions, and how frequently should it be done? In this first prototype, Merry Miser asks users to assess each transaction four times. This may be excessive in the long run, and it is possible that the application would be as effective with only one assessment.

- How effective are representational features such as contracts, metaphorical currencies, and the graphical display? If the features are not useful, they should be removed to streamline the application.

Testing these features would benefit from more carefully designed controlled experiments, and larger test populations. A difficulty in designing these experiments will be in determining what length of test would be appropriate. As the goal is long-term behavior change, long-term experiments could be the most effective, but are also more costly and administratively difficult.

Chapter 4

Conclusion

The problems many people face with spending are compounded by the myriad of forces which take advantage of them by creating needs and desires for more spending. While research in positive psychology seeks to describe the types of behavior that lead to the best livelihoods, ultimately, the choice of which lifestyle (and what sort of spending behavior) is a matter of opinion and cultural context. Persuasive technology provides powerful tools which have the potential to help people to overcome impulses or forces which steer them against their better interests, but the designers of the technology face the difficulty that their applications reinforce particular opinions or cultural contexts as to what lifestyles are best.

Merry Miser seeks to persuade people to make better choices with their money. It attempts to navigate the milleaux of cultural context and opinion by relying on reflection and customizable representation of money, rather than promoting any particular spending behavior (though this approach is acknowledged to not be without its biases). Test users of the application generally had positive comments about the approach and design, but encountered difficulties with the robustness of the implementation. The various ideas presented in the design of this application are likely to be fruitful areas for future research.

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Appendix A

Transaction Geocoding Server REST API

If successful, all methods return a HTTP status 200 and a JSON [1] object of the following format (even if there are no matching merchants, in which case the "results" will point to an empty array):

```
{ results: [{
        'merchantid': unique merchant ID,
        'name': name of the store,
        'city': city,
        'state': state,
        'street': street address,
        'latitude': latitude,
        'longitude': longitude,
        'catalog': True if this is a catalog/internet store, false otherwise,

        // optional values if available:
        'zip': zip code,
        'phone': phone number
```

[1] Javascript Object Notation, see http://json.org

```
        'memos': [
            {'memo': transaction memo, 'votes': number of votes for this memo/merchan
            ...
         ],

    }, ...]
}
```

All unsuccessful requests (resulting from invalid parameters) result in an HTTP status 400 (bad request).

A.0.1 Requests

Adding a merchant

```
POST /merchant/add/

desc: Publish a store and its location.

params: required: 'name': store name,
                  'city': store city,
                  'state': store state,
                  'street': street address
                  'latitude': latitude,
                  'longitude': longitude
        optional: 'zip': zip code, 'url': store url,
                  'catalog': true/false (indicates the store sells via catalog
                             or Internet)
```

Searching for merchants

```
GET /merchant/find/
```

```
desc: Searches for merchants with given parameters.

params (all optional, but latitude and longitude must be used together):
    latitude: latitude,
    longitude: longitude,
    radius: search radius, (default 100 meters)
    name: store name,
    memo: transaction memo
    results: number of results to return (default 4)
    page: "page" of results to return (default 1)
    catalog: true/false, is store a catalog/Internet store?
```

Adding memos and matches between memos and merchants

```
POST /merchant/memo/

desc: Publish a match between a store and a transaction memo.
      Indicates a "vote" for this pair of store/transaction memo.

params:
    memo: transaction memo,
    merchantid: primary key of Merchant, as returned using /merchant/find
```

A.0.2 Memo Filters

Transaction memos will be filtered on the server side to remove personally identifiable and unique strings. Clients are welcome to also filter prior to upload. The filters include the following regular expressions – anything matching them will be stripped.

- `(\d{2}\-\d{2}\-\d{2})` – filter out date strings
- `(auth# \d+)` – filter out auth tokens

- `(POS \d+ \d+ \d+ \d+)` – filter out point of sale tokens
- `(\d{4} \d{4} \d{6})` – filter out ATM tokens, but leave keyword "ATM" in

Appendix B

Happiness and spending quotes

The following is a collection of quotes which are randomly shown to Merry Miser's users when they go to a store. The quotes are collected from (Schumaker 2007) and other sources.

- "Happiness is a way station between too little and too much." — Channing Pollock
- "We travel through life searching for the beautiful, but unless we carry it with us as we go, we will never find it." — Ralph Waldo Emerson
- "If you want to be happy, be." — Leo Tolstoy
- "It is the sides of the mountain which sustain life, not the top" — Robert Pirsig
- "Remember that happiness is a way of travel — not a destination." — Roy M. Goodman
- "Appreciation can make a day, even change a life" — Margaret Cousins
- "To happiness the same applies as to truth; one does not have it, but is in it." — Theodor Adorno
- "But what is happiness except the simple harmony between a man and the life he leads." — Albert Camus

- “The goal of life is living in agreement with nature.” — Zeno of Elea
- “A tear dries quickly when it is shed for the trouble of others.” — Marcus Tullius Cicero
- “Nothing is enough for the man to whom enough is too little.” — Epicurus
- “Never value anything as profitable to thyself which needs walls or curtains.” — Marcus Aurelius
- “I know what the cure is: it is to give up, to relinquish, to surrender, so that our little hearts may beat in unison with the great heart of the world.” — Henry Miller
- “He who never knew the price of happiness will not be happy.” — Yevgeny Yevtushenko
- “The deeper that sorrow carves into your being, the more joy you can contain.” — Kahlil Gibran
- “Contentment is a pearl of great price, and whoever procures it at the expense of ten thousand desires makes a wise and happy purchase.” — John Balguy
- “Be happy with what you have and are, be generous with both, and you won’t have to hunt for happiness.” — William E. Gladstone
- “‘Well’, said Pooh, ‘what I like best—’ and then he had to stop and think. Because although Eating Honey was a very good thing to do, there was a moment just before you began to eat it which was better than when you were, but he didn’t know what it was called.” — A. A. Milne
- “To be without some of the things you want is an indispensable part of happiness.” — Bertrand Russel
- “The wisdom of the world consists in making oneself very little.” — Robert Luis Stevenson

- "I don't know what your destiny will be, but one thing I do know: the only ones among you who will be really happy are those who have sought and found how to serve." — Albert Schweitzer

- "The sage leaves no footprints when he passes through the village." — Chinese Proverb

- "A rock stands
  where I kneel." — Cid Corman

- "O Snail
  Climb Mt. Fuji
  But slowly, slowly!!" — Kobayashi Issa

- "If you want others to be happy, practice compassion. If you want to be happy, practice compassion." — The Dalai Lama

- "We act as though comfort and luxury were the chief requirements in life, when all we need to make us really happy is something to be enthusiastic about." — Reverend Charles Kingsley

- "It was the best place to be, thought Wilbur, this warm delicious cellar, with the garrulous geese, the changing seasons, the heat of the sun, the passage of the swallows, the nearness of rats, the sameness of sheep, the love of spiders, the smell of manure, and the glory of everything." — E. B. White

- "A certain power of enduring boredom is essential to a happy life." — Bertrand Russel

- "If things do not turn out as we wish, we should wish form them as they turn out." — Aristotle