Fit4Life: The Design of a Persuasive Technology Promoting Healthy Behavior and Ideal Weight

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ABSTRACT
This is a critical design paper offering a possible scenario of use intended to provoke reflection about values and politics of design in persuasive computing. We describe the design of a system—Fit4Life—that encourages individuals to address the larger goal of reducing obesity in society by promoting individual healthy behaviors. Using the Persuasive Systems Design Model [26], this paper outlines the Fit4Life persuasion context, the technology, its use of persuasive messages, and an experimental design to test the system's efficacy. We also contribute a novel discussion of the ethical and sociocultural considerations involved in our design, an issue that has remained largely unaddressed in the existing persuasive technologies literature [29].

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Persuasive technology, weight loss, social implications, critical design.

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General Terms
Design, Human Factors, Measurement.

INTRODUCTION
The American population is fat. In 1994 more than 54% of adults had a body mass index (BMI) that qualified as overweight or obese [13]. By 2006 this number had skyrocketed to almost 73% [2]. This statistic is alarming, as obesity has been linked to many health problems, several of which can be reduced by a 5-15% weight loss [3].

Americans have not ignored the obesity epidemic; millions are trying to lose weight [1]. In 2000 this was true of 46% of American women and 33% of American men [8]. Despite the existence of a simple equation for weight loss—consume fewer calories than you burn—the North American weight loss industry amasses an estimated $50 billion in revenue every year [4]. The industry as a whole promotes a number of weight loss measures, from diet pills through strict diet and exercise regimes to hypnosis. However, Weight Watchers is the only commercial program shown to be effective in a controlled trial [1] and American waistlines are still on the rise.

To address this problem we have designed a new weight loss technology, Fit4Life. Our system design is based on a number of the literature-supported principles seen in existing weight loss programs, including mechanisms to track calorie consumption and exercise activity along with a social networking component where people can celebrate their success and receive motivation when they find themselves failing. We also address the primary reasons attributed to the failure of existing programs: that people are required to spend too much time tracking their diet and exercise, and that they have the ability to not participate fully by not tracking all food or not following an exercise plan. The key innovation in our approach follows from persuasive technology literature where human behavior is often considered the weak link in accomplishing a greater goal [29]; we use this literature to inform the selection of methods to convince people to develop healthier behaviors.

We begin by describing the literature on behavioral weight loss methods and their lack of effectiveness. Next, we use the Persuasive System Design (PSD) Model framework to present the Fit4Life system as a solution to these behavioral treatment failures. We then present our directions for future work and discuss the ethical and sociocultural considerations involved in the Fit4Life system design.

WEIGHT LOSS METHODS
After making the decision to lose weight, one is faced with many methods that promise to help shed unwanted pounds. The majority of these programs attempt to alter diet and exercise behavior in order to achieve weight loss. The prevalence of these behavior-oriented programs is justified by studies that show participants enrolled in structured behavioral treatments lose significantly more weight than those who use self-help resources [18, 28].

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Behavioral Weight Loss Principles and Effectiveness

Behavioral treatments were first introduced in the 1970s and represented a conceptual landmark in obesity treatment [20]. Researchers promoting these approaches argue that the most effective way to change diet and exercise is by changing environmental factors. Factors to be changed can either precede behavior (e.g. restricting types of food available, prompting exercise by placing sneakers close to a door) or be in the form of positive or negative consequences of behavior (e.g. receiving points for healthy behaviors, social criticism for unhealthy behaviors).

While these behavioral change programs are more effective than self-help programs, they result in a mean loss of less than 5% of initial weight [1]. Weight loss success is usually defined as a 10% weight loss [19], so these programs are arguably unsuccessful. Even within the small number of participants who achieve a 10% weight loss, one study showed that after four years participants' weight was only 4% below their baseline [19]. Failure in these behavioral change programs is almost always cited as resulting from participants' inability to follow the prescribed diet and exercise changes [15].

Behavioral Weight Loss Technology

We analyzed 33 technology-based behavioral change programs for weight loss to determine how these programs enact the literature described above[2]. These programs vary in type of behavior change promoted (e.g. eating behavior, exercise behavior, or both), and the medium used (e.g. online, offline, mobile phone, a combination of the above), but are overwhelming similar in their methods.

Most of the programs include an initial assessment where participants enter their weight, height, age and gender to determine their starting BMI. Next, the programs require a goal such as desired weight or number of fitness minutes per week to be set. All of the 33 programs use a tracking paradigm to promote behavior change, requiring participants to record fitness minutes, caloric intake, and/or weight. A few of these programs also include tidbits such as inspirational quotes and articles about success stories or how to avoid common pitfalls, often addressing the change of environmental factors preceding behavior. Some programs include community-based components such as forum boards and groups where participants can communicate and set group goals. Many of the programs also send emails to participants to encourage them to continue with the program. One particular program also uses points to encourage diet and exercise behavior.

A PERSUASIVE TECHNOLOGY APPROACH

We believe that these programs fail in two broad ways: 1) by placing the burden of tracking on the participant and therefore contradicting the behavioral treatment principle of requiring less effort and 2) by allowing the participant to choose which information is "front stage" (what they do report) and which information is "backstage" (what they do not report) and therefore undermining the program's ability to provide consequences and rewards to the participant.

Fit4Life addresses these problems by capitalizing on three strategies from the persuasive literature. First, we are motivated by [9] to design technology for people's everyday lives. Second, we are motivated by [14] to encourage new behaviors by making them simpler. Third, we introduce new rewards and motivations to encourage behaviors that address the social problem of obesity [29].

We employ the Persuasive Systems Design (PSD) model [26] as a framework to explain our approach. The PSD model helps to structure thinking about a persuasive system by providing a map of persuasive design techniques to system requirements. Above we described our understanding of the fundamental issues driving the need for the system, which is the first step in the PSD process. The second step is to build the "persuasive context" where the system designer selects behavioral changes that they wish to induce and the strategies for doing so. Finally, actual system qualities are designed. In the following sections, we discuss the persuasive context, its implementation, and the persuasive strategies used to map between the two in the Fit4Life system.

The Persuasive Context

In the Fit4Life system, "the persuader" is, at one level, the system designers. However, at another level, Fit4Life becomes a mediator to allow other individuals, both face-to-face and on social networks, to become persuaders and influence each user to "do what is best for them."

Like other persuasive computing designers, we focus on modifying behavior because modifying attitudes seems too difficult [29]. At the macro-level, the goal of the Fit4Life system is to introduce a change in each user's eating and exercise behavior. This change will make users aware of situations that might negatively impact the maintenance of their ideal weight. In this sense, we choose to place less priority on understanding the goals of the individual user in favor of maximizing the possible utility from reducing societal health care costs associated with obesity. Optimizing the system to achieve the user-in-societal goal of reducing obesity will not only improve the health of working Americans, making them more productive, but, also has the effect of helping each participant become more attractive, and, therefore, more socially acceptable.

To help users achieve weight loss, the Fit4Life system has four primary sensors and a few other components that are operated using the Fit4Life iPhone Application. Fit4Life's Data Recorder makes use of image processing algorithms to estimate the calories of food consumed. Attached to the Data Recorder is the Beacon Accessory, which acts as a visual indicator of the individual's progress. The Earpiece

[2] For a list of programs, criteria for selection, and detailed analysis, visit: http://www.victoria.schwanda.org/fit4life.

is a Bluetooth receiver that, as with all of the peripheral devices, has been networked with the iPhone. This medium allows for direct audio communication with the user. The Earpiece also measures jaw movements to track eating behavior. The Thinsert is an electronic scale that can be inserted into a sock or shoe depending on the user's preference. The Heart Rate Monitor is worn around the user's chest to determine exercise behavior. The Metabolic Lancet is worn on a toe and it is used to analyze blood to determine current metabolic rate. The Support Cloud is implemented as a connector to Facebook and other social networking sites to broadcast the user's progress.

Use and User Context

To function as a weight management tool, the Fit4Life system must be capable of evaluating the current fitness of the individual at any given time [11]. This is accomplished by quantizing fitness into a model derived from data from the Fit4Life sensor network.

New Fit4Life users begin with an Assessment and Configuration phase. Given the user's height and age, the system determines the user's BMI and the correct diet and fitness plan for the user. The Fit4life system then describes the user's current fitness level and the system's plan to help them achieve a BMI in the ideal range.

The Fit4Life system combines the input of all of the sensors to assist the user in achieving their Fit4Life goal. We have developed a model that maps observed sensor inputs to Present Lifestyle Context (PLC): a vector that contains Daily Calories Consumed, Daily Calories Expended, Body Mass, Metabolic Rate, and Heart Rate, in addition to a few other proprietary variables. The system performs this assessment every second. With the PLC, Fit4Life is able to assess the current fitness of the user. The system provides feedback and suggestions to the user and informs others when the user needs encouragement to ensure Fit4Life-appropriate choices.

The Data Recorder observes the food consumption of a user. It is worn on the body and is placed such that it can determine the caloric content of food that is being consumed. When the Data Recorder has determined that the user is consuming food, the caloric content of the ingested food is added to the current value of Daily Calories Consumed. Data from the Heart Rate Monitor is combined with data from the Metabolic Lancet—which performs periodic blood tests—to determine the current metabolic rate. Observations of metabolic rate map to Daily Calories Expended and Metabolic Rate and data from the Heart Rate Monitor maps to Heart Rate. Finally, body mass is recorded daily using the Thinsert and maps to Body Mass. With the PLC, Fit4Life is able to assess the current fitness of the user and develop feedback and suggestions to provide to the user through the Earpiece. Recognizing that each user needs community support, the Beacon Accessory and the Support Cloud inform others that the user is in need of encouragement to ensure Fit4Life-appropriate choices.

The Persuasive Strategy

As outlined by the PSD model, the strategy of a persuasive system is executed via messages sent by the persuader to the user and by the routes the messages take to reach and persuade the user. Routes can be direct, indirect, or both. Routes are considered direct when the system provides information, such as calorie count or total calories expended for the day to the user. More subtle forms of persuasion are considered indirect routes. In the Fit4Life system, many messages and routes are employed, but in this section we list a representative sample of the techniques by the component of the system that serves as the route for persuasion. The Fit4Life system makes use of many of the persuasive design principles in primary task support (see [26]) including self-monitoring, reduction, tunneling, tailoring, personalization and social comparison.

Since Fit4Life tracks the performance of the user in all relevant categories to support the user's goal of weight management, it implements self-monitoring by providing a mechanism for the user to track their performance on metrics relevant to achieving that goal. The entirety of the Fit4Life system can be seen as an effort to reduce the complex task of weight management, beginning with "wear the Fit4Life system at all times"—an implementation of the persuasive reduction principle. In addition, calendar integration between the iPhone and Fit4Life simplifies scheduling. Instead of the complicated task of calorie awareness, the Data Recorder and the Earpiece work together to perform a sophisticated scientific analysis of food intake and eating behavior, with simple feedback to inform the user of their decisions.

Fit4Life tackles another complicated task—decisions about diet and exercise. It is engaged continuously to persuade users to make appropriate Fit4Life choices. In doing so, it uses the persuasive tunneling principle to "guide a user through a complex experience and persuade along the way" [26]. Since Fit4Life provides information when directly relevant to the user's behavior, and since that information is customized to the user's needs at every instant, the system employs principles of both tailoring and personalization. Finally, social support—and thus social comparison—is mediated through the Fit4Life Support Cloud.

The Fit4Life Support Cloud

Each user is assigned to a monitored treatment group on Facebook. Additionally, Facebook is periodically updated with each user's progress against their personal goals. When a user's eating and exercise behavior is in balance with their goals, the system generates a Wall post once per day that praises the appropriate behavior. When a user's eating and exercise behavior is not in balance with their goals, the system periodically generates a Wall post to notify others to provide encouragement. Additionally, if the user is not wearing components of the Fit4Life system, Wall posts are generated every hour notifying others that the user needs encouragement. Examples of the Wall messages generated by the system include the following

(note that the primary persuasive design principles and Dialogue Support [26] are tagged next to each message):

> "Congratulations! You've had a perfect Fit4Life day. At this rate, only one more day until you're the perfect weight!" [Personalization, Praise]
>
> "Fantastic! You're at your ideal weight! If you exercise just once more this week, you'll have achieved all of your Fit4Life goals." [Tunneling, Praise]
>
> "Shucks. You've gained an extra pound today because you consumed too much food and you didn't exercise. If you take a 30 minute walk tomorrow, you'll be back on the right path!" [Personalization, Suggestion]

We also include a sampling of messages left on other people's Walls by group participants:

> "Wow! You look great! You're Fit4Me!" [Social]
>
> "Bobby Joe, you can do it! We'll hang out tomorrow and have some carrot juice instead of beer."[Social]
>
> (Next to a picture of a bikini that was attached to the post) … "Lucy, how are we going to pick up guys at the beach next month?!?"[Social]
>
> (Next to a picture of a wedding dress that was attached to the post) … "Libby, are you going to break your mother's heart on your wedding day?" [Social]
>
> (Next to a picture of a wedding dress that was attached to the post) … "Libby, you'll look fabulous in your slimmer dream dress!" [Social]

The Fit4Life Data Recorder and Beacon Accessory

The Beacon Accessory displays user status via a blinking scarlet light. When a user's behavior is in balance with their goals, no light is emitted from the device, but when out of balance, the beacon accessory blinks to notify others to provide encouragement. As with the Support Cloud, the alert rate is proportional to the imbalance in behavior—until a constant stream of scarlet light is emitted, indicating a need for immediate assistance.

The Fit4Life Earpiece

Suggestions are frequently delivered via the Fit4Life Earpiece, which is the primary vehicle for delivering direct suggestive persuasive advice to a Fit4Life subject. The advice provided by the system can take many forms, ranging from telling the user how many calories they are about to consume to direct suggestions about whether their decisions are in line with their goals. Examples include:

> "Dave, your schedule seems to be filling up. Would you like to schedule time for a walk by the river today?" [Tunneling, Reminder]
>
> "Dave, you're scheduled to have dinner with Lisa's parents this evening. They wish to eat at Moosewood, which has many healthy options. You might enjoy one of the cookies on the table now." [Tunneling, Suggestion]
>
> "Dave, the scone you are about to eat probably contains 400 calories. You've already consumed 300 calories today. There are 9 hours remaining in your wake period. After eating the scone, you will have consumed 45% of your total nutrition needs for today. You have free time today from Noon to 2 pm. Would you like me to schedule a long run?" [Reduction, Suggestion]
>
> "Dave, you've eaten the scone and you didn't run with me yesterday. I would like to go for a run soon." [Personalization, Suggestion]
>
> "I'm sorry, Dave, you shouldn't eat that. Dave, you know I don't like it when you eat donuts." [Personalization, Suggestion]

The Fit4Life system is visualized in Figure 1.

FUTURE WORK

Using evaluation protocols common in the persuasive literature [29], we will demonstrate system efficacy using 26 student subjects grouped using a randomized block design over a 9-week period. Study participants are given free access to the Fit4Life system during the experimental trials. Each group will be pre-tested for weight, BMI, and fitness level. The study requires all test group participants have a diet and exercise regime that will result in a body mass within the acceptable range. We hope to find at the end of the trials that Fit4Life users are more likely to have BMIs in the acceptable range than Control group users.

Additionally, we plan on upgrading our sensor network to enable analysis of chewing sounds for dietary monitoring [4] and body fat calculation via bioelectrical impedance analysis. Planned upgrades also include the use of LED tattoo technology [22] and custom voice selection for the Earpiece so users can choose to receive feedback from people such as their mother or wife. We also plan to offer more fashion conscious versions of our sensors through partnerships with celebrity designers. Finally, our celebrity partners are developing and endorsing diet and exercise plans to be available to future Fit4Life users.

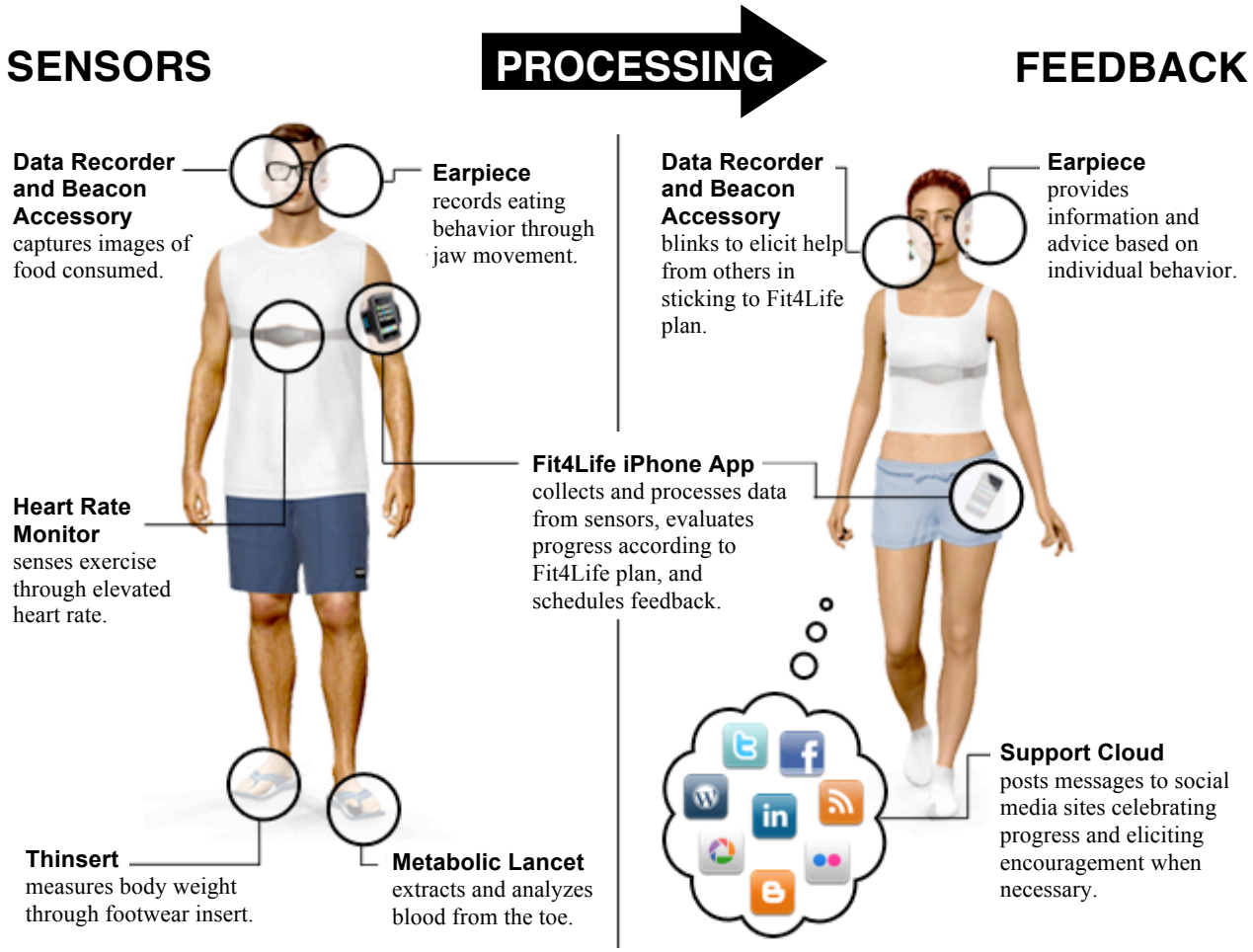

Figure 1. The Fit4Life system in use. All components of the system are shown including sensors, the processing unit, and feedback mechanisms. Certain system components such as The Fit4Life Data Recorder and Beacon Accessory are available in multiple forms (shown here as prescription glasses and fashion earrings) and perform both sensing and feedback functionality.

DISCUSSION

Fit4Life is a fictional, critical design. Our goal is not to present a persuasive computing system to solve the problem of obesity but rather to demonstrate how easily such a design can spiral out of control, and through this, explore the ethical and conceptual limits of persuasive computing. Our goal in the first half of this paper was to take the persuasive technology and obesity research literatures at their word and see how far we could implement their logic and recommendations. In order to do so, we carefully documented each design decision, no matter how outrageous, with specific references to the persuasive design literature that justifies it.

Fit4Life is intended not as a practical design solution but as a thought experiment to stimulate reflection on the social, ethical, and political issues that technology raises. Our critical intervention is addressed to designers of persuasive and ubiquitous systems and aims to unearth issues of meaning and value, of ethics and responsibility. Our purpose is not to lambaste practitioners of persuasive computing; as practitioners ourselves, we aim to demonstrate the limits of what we perceive as common approaches in the field by pushing these approaches to their logical conclusion. Our aim is to unsettle, but we are aware that the design of our paper can arouse negative sentiments, particularly since our parody is not made explicit until this section. This decision was carefully made to maximize critical reflection. Our fear was that if the parody were clear initially, we would run the risk of a complacent reading of such design as not truly possible. Our hope is that readers will evaluate for themselves the extent to which Fit4Life's design elements are realistic reflections of technological research trends.

Our approach is based on intellectual precedents in activist literatures. In our design, we follow traditions of tactical media [23] in aiming for a fine line between humor and realism to highlight how frighteningly close reality can be to a joke. We are inspired by Dunne and Raby's notion of critical design, whose goal is not to provide clear answers but to provoke reflection [10]. We believe the ethical and value issues related to persuasive design need to be actively

discussed by the community. Our goal is not to tell the community what to think but to help provoke discussion.

In this discussion section, we describe the key critical issues that our design is constructed to explore. At the highest level, we see persuasive computing as conceptualizing itself in terms of structured, rational approaches to optimizing individual behavior, frequently for goals which are not chosen by the individual. This conceptualization raises three critical issues. First, persuasive computing raises issues around the borderlines between encouragement, persuasion, and coercion, and specifically with who should be in control of individual behavior. Second, we see persuasive computing as participating in and reinforcing broader troublesome cultural trends to control, rationalize, and optimize human behavior. Third, persuasive computing's use of technological control raises issues around surveillance and around what is lost through the process of quantification.

Persuasion or coercion?

Our design explores the boundary shared between persuasion, encouragement, and coercion. This recurring theme was designed to encourage system designers to consider whether their persuasive strategies are really control or persuasion. For example, by sublimating the designer's ideology as the "system's" Fit4Life obscures the question of just whose ideas of fitness and diet are being enacted and treats the user as a 'technological dope', "an automatic, almost reflex substantiator and re-enactor of [dietary] cultural norms, with little recognition of … individual experiences, awarenesses and reflection" [30].

We constructed the support cloud and beacon to demonstrate the potential shortcomings in such social support approaches. As designers, such measures may seem at first as enabling as they allow users to solicit help in achieving what at first appears to be solely their own goals. But when viewed critically, the beacon appears as both a signal for help and an element of shame. While soliciting support for the user it also highlights his or her non-conformity to personal and social norms and an inability to stick to plan. We believe that this shame, regardless of social or physical distance, is coercive. Fit4Life exploits that inherent tension between eating and exercise, and capitalizes on users' dissatisfaction with their own fitness and health to induce behavior that is acceptable to a wider group and uses "objective" standards as reinforcement.

Fit4Life's design decisions frequently sacrificed individual good for the social good—by providing avenues for unpleasant peer pressure, for example. In doing so, we try to highlight the distinction between providing people with tools for reflection on the impacts of their practices to achieve *social* goals (as suggested, for example, by [7]) and providing people with tools for reflection on the impacts of their practices to achieve *their own* goals. While personal goals are always culturally influenced, the key distinguishing feature that concerns us with the persuasive computing literature is that users do not get to choose their own viewpoints, but are provided with one by designers.

More broadly, persuasive computing raises questions on the ethics of changing another's attitude, belief or behavior. In considering an ethical boundary situated around a user's intent we must ask if a choice can even honestly be made to take away one's choices. This is not a straightforward examination given that persuasive technologies frequently aim to make behavioral decisions 'simpler' by eliminating complexity (and options), and often aim to enforce sublimated social goals. Is it ethical to exploit fears and anxieties in service of such goals? Are users allowed witness to the origin and full extent of these changes?

While we used the terminology and design practices of the persuasive computing movement, the complete Fit4Life product—in its extremes—highlights a need for reflection through non-judgmental means rather than persuasion to achieve an ideal. In this way, it suggests that an ideal system might be a subjective one that would allow users to define their own meanings and values.

A persuasive society

At the onset of our project we believed that our design would be quickly recognized as satire. As our work progressed, however, we realized that our design could likely actually be marketed and accepted in mainstream society without recognition of its commentary due to a mutually reinforcing relationship between worrisome aspects of persuasive computing and a broader incursion of scientific rationalization into our everyday lives. We see persuasive computing as embodying a 'McDonaldized' [27] worldview that values quantification and rationality at the cost of situational, hard-to-measure factors and sees scientific measurement as obviating personal experience. Through Fit4Life's design, we hope to provoke conversation about the meaning and value of a broader, pervasive rationalization of our lives.

We chose diet and exercise as domains for Fit4Life because they culturally embody those principles. The tie between diet and exercise and concepts of persuasion became clear when our survey of literature and websites revealed a plethora of exercise promotion tools and calorie trackers that circumscribed plans of action and offered persuasive sticks and carrots to ostensibly guide users towards correct behavior. We saw how popular diet and exercise planning tools and programs encourage a shift of responsibility from individuals to external sources [24]. Late night infomercials promise quick weight loss drugs or exercise machines that ignore the varying situational needs and dietary habits that are crucial to our self-definition. The increased reliance on scientific measures of healthiness has left users ever more uncertain of what to eat and increasingly dependent on scientific experts to inform them.

These aspects of diet and exercise can be seen as embodying broader cultural trends that Ritzer terms

McDonaldization: referring to the permeation of structured, rational approaches throughout American society, and the emphasis of the attributes of efficiency, calculability, predictability, and nonhuman (frequently technological) control. Following the theories of sociologist Max Weber, Ritzer highlights the 'irrationality of rationality' – the ways in which too great an emphasis on these individual rational attributes leads to solutions that are globally irrational.

Diet programs based on the models of efficiency and calculability abound: the right amount of protein, carbohydrates and fat cooked and consumed in the smallest measure of time. We now seek to lose weight in a manner that parallels the way in which we gained it: quickly, mindlessly and conveniently. By pulling quantitative measures to the foreground over qualitative ones, and usurping (or "complementing" in marketing-speak) the normal situational human decision making process, the Fit4Life system is an embodiment of this worldview.

We have pointed to statistics that show that obesity levels are increasing rapidly due to a variety of factors, but poor diet and an increasingly sedentary—yet somehow busy—lifestyle, are the most notable. Strikingly, many of us simply can no longer determine what eating properly entails (if there even is a single answer to that question). In developing this critique, we tried to take care to avoid defaulting to a romantic desire to return to a past that can no longer exist. Can we really return to a world without such systems and controls? While we can be concerned about the over-application of rational models of control and efficiency to human experiences [27], it would be disingenuous to simply put forward a design modeled on inefficiency and unpredictability when the market demands otherwise. Instead we choose to raise this question: do our desires for such controls indicate a need to be seen as and feel contemporary or modern?

We designed Fit4Life in the spirit of what we believed to be that modern zeitgeist. In particular, we conceived of configurable celebrity-endorsed packs as an example of loci of control that are external, corporate, and rational and the iPhone application node reflects a desire for a simplified control panel for our lives. Will our future ability to manage our diet and exercise be finally determined by technological innovations like Fit4Life? Though our literature review indicates that this might be the hope and direction of modern man, it also highlights the sea of continually updating, often contradictory, dietary information through which such a path must be chartered.

Technological control

Given the cultural value of technological control, an increase in the domain of machines in our health management seems all but inevitable through dining room tables that "sense the movement of food from the serving container to the individual consuming it," sensor-augmented kitchen knives, cutting boards, and on-body sensors [17]. Our design, by taking this idea of tracking and persuasion to its logical extreme, challenges the idea that increasing the volume and fidelity of data captured can result in a long-term healthy attitude.

Through our design we imagined a world where all of the data needed to quantify a user's fitness could be collected. A strain of belief in the literature we reviewed is that if people reported all this relevant information, then experts would be unrestrained in their ability to help users help themselves. Fit4Life's notion of quantizing fitness and health into a feature vector based on sensor input and system designer options relies on intrusive, obvious, and perhaps even ridiculous sensors, but similar methods are showing up in the literature [5]. The lancet intermittingly drawing blood from your system and the earpiece measuring jaw movements may seem ridiculous at first blush but these decisions set the stage for an examination of what happens when system designers have an unfettered visibility into user's lives that is coupled with realized intrusion.

One issue with the formal models derived from sensed data used in Fit4Life is that positive behavior is identified solely with reducing BMI. In choosing such a fixed model, the system reinforces a narrow conception of what it means to be healthy or fit. By focusing on quantitative measures the system also discards the value of personal experiences and emotions for a utilitarian position on the value of food and exercise. Because of the inherent limitations of sensing, persuasive systems often promote behaviors based on limited understanding of users' actual personal situations.

But even if unlimited data acquisition is possible, there are issues of surveillance and privacy. With Fit4Life, users are monitored constantly and must behave accordingly. Foucault, in speaking of the Panopticon, notes: "we live in a prison-like society founded on discipline and surveillance. The formation of this society stems from many historical processes, but it is a surveillance society and its purest form is the prison." Conceived in this way, the Fit4Life system is not only a design artifact but also embodies a schema "for characterizing many aspects of society" and is "[a] diagram of a mechanism of power reduced to its ideal form" [Foucault in 21]. This is an embodiment of utilitarianism wherein behavior is evaluated strictly according to its utility in lowering BMI and in constraining the user in order to enact social goals.

Fit4Life is then a rational cage that showcases the "irrationality of rationality" [27]. It is a personal prêt-à-porter panopticon. Fit4Life represents an incursion of a rationalistic, objective view of the world that is often hidden in the agendas of persuasive designers. This cage can be seen as a "rationalized setting" where the "self [is] placed in confinement, its emotions controlled, and its spirit subdued" [27]. By seeking to reduce basic human flaws (or characteristics depending on your slant), the persuasive agenda embodied in this design is dehumanizing.

The feasibility of such a design is increasing. Fit4Life's Present Lifestyle Context is a vector of measurements because a persuasive system that includes machine-learning components would, essentially, construct a vector of sensor measurements and historical user responses to provide suggestions tailored to increase compliance. If a user is most likely to comply if the system posts a Facebook message, a machine learning system could learn that aspect and act accordingly. The system may not even be sophisticated enough to know that for a specific user, the Facebook route is effective because the user's mother functions as an enforcer. System designers face the tension between the increased system efficacy possible from using machine-learning systems to tailor user suggestions and the side effects that can be created by a reliance on effective but unseemly persuasive routes.

IMPLICATIONS FOR PRACTICE

Expanding Criteria for Evaluation

One clear implication of the Fit4Life design is that evaluation needs to be expanded beyond the explicit goals of the system to include attitudes (not only behaviors) and unintended consequences.

The Fit4Life system focused on changing user's behaviors, and not their attitudes, which is a common practice in persuasive technology [29]. Success is measured during a 9-week period—a fairly short evaluation period, also common in the literature [29]—and our main critieria for success was that users reach a certain BMI as measured by our system. As practitioners, we know this is an extremely short-sighted method of evaluating whether users remain fit and healthy. As a designer, is the appropriate role to persuade users to achieve an ideal BMI in 9 weeks or is it to help the user live a healthier life?

As the designers of Fit4Life, we wanted to show that when people use the system the outcome would be users with ideal BMI. As critical reviewers of Fit4Life, we think it is unrealistic that people would use the system for the rest of their lives and that they may develop behaviors when using the system that are not sustainable. Therefore, we find the evaluation—the focus on measuring the outcome of achieving ideal BMI—flawed because it doesn't assess the true impact of the system on the user. This difficulty is common to other persuasive studies [29].

Additionally, the Fit4Life evaluation should have included more holistic measures of the users physical and mental well-being. In this respect, we should have been diligent about looking for unintended consequences, including stress in their personal relationships and their self-image. In medical studies, it is common to examine unintended problems or adverse events from a treatment. In persuasive research designs, how is this facilitated? And what would be the definition of an adverse event? Would it include feeling stressed and pressured by your mother on Facebook to fit into a size 2 wedding dress?

The American Food and Drug Administration has evolving recommendations for dealing with adverse events in treatment. Patient advocates, industry veterans, and government representatives work in cooperation and conflict to resolve definitions and protocols. By exaggerating and integrating persuasive design principles in Fit4Life, some of their potential weaknesses become more apparent. In this sense, the critical design method employed to produce Fit4Life can be used to explore similar discussions for evaluating potential technical designs.

In our case, Fit4Life was designed to achieve a societal goal at the potential loss of mindfulness. We chose explicitly to frame loss of mindfulness as an unimportant side effect in our exaggerated design, but designers working on the development of different systems might choose other potential harms.

Designing for mindfulness and leaving room for stories

The principles of reduction, tunneling, and tailoring are most used in the persuasive technology literature [29], and taken together encourage designers to make it easier for the user to act in a manner consistent with their system's message. A system following these principles would guide a user through accomplishing a complex task in a manner that is customized and simplified to the user's personal situation. The Fit4Life earpiece is an example of these principles in their extreme. It provides explicit verbal suggestions when specific foods should be eaten or avoided and when the user should engage in specific fitness activities based on the PLC and the user's current surroundings and schedule. The user no longer has to calculate calories consumed and expended to determine for themselves whether they are within their daily calorie allowance and they no longer have to use this information to make food and exercise decisions—the system does this for them. In an effort to make this process easier, we took away the user's ability to reflect on their situation and decide on appropriate action. We are telling them *exactly* how to behave in every situation.

Even if we accept the idea of diet and exercise planning as a valid part of the realm of personal, everyday computing, we need not agree that everyday computing need be everywhere computing or that everywhere computing needs to be mindless computing. We hope that Fit4Life's encompassing and detailed model of calorie consumption and expenditure exposes arguments on the uncertainty inherent in such measures and on the importance of mindfulness on the part of the designers and system users. Allegiance to Fit4Life discourages mindfulness when mindfulness might be precisely what users need to develop for building attitudes important for sustaining long-term health.

Perhaps, in the end, this should be the goal of more exercise and diet programs: not to supplement or to make decisions for users but to eventually wean them by helping to establish self-reliance. If obesity is viewed as a disease,

then the focus can be more readily seen as on lifestyle, on the management of a chronic condition and in helping users develop an internal locus of control. In such a situation the "individual discovery of patterns and correlations in past experiences" [24] is as important as the system's persuasions and controls. Reflection is then one of the most important skills to develop in order to help users build a "sense of control over their disease and their perceived role in [its] management" [24]. It is important then to not focus solely on restoration to an ideal state but also on the revelations that users achieve while using the product [24].

In exploring alternative conceptual designs, Gaver notes that "if people are enabled to play a substantial role in determining the meaning of systems...they will be actively engaged in the process of understanding both the system and its situation of use" [16]. He goes on to call out—importantly—that an "active engagement in sense-making may not only be pleasurable or liberating, it may also be useful in safety-critical applications" [16].

While not immediately safety-critical, exercise and diet planning regimes could be more effective (although the very question of "effectiveness" is at stake here) if they incorporated similar strategies for encouraging mindfulness. By exposing rather than covering seams [16] in the abilities of calorie or exercise tracking, the hope is that users would be encouraged to reflect on how they feel, rather than relying on the illusion of an impeachable, scientifically objective source of measurement.

But what is appropriate behavior? Fit4Life focuses on an objectively agreed upon metric for healthiness, the BMI. Should the focus be on numerical values of calories or macronutrients, the distance one's food has travelled, or on the feelings of community and wholesomeness that often accompany the act of eating? How we feel about the way we eat is important in maintaining healthy habits, and how any diet management or tracking system allows for self-presentation and makes room for users' stories [6] is arguably as important as the very measures it tracks.

Fit4Life destroys strategies for misrepresentation or secret consumption that could have allowed for any idealized impressions of behavior that an individual could have conveyed [9]. If it is accepted—and we do—that these are strategies essential for long term adoption, the accuracy and entirety of information capture should be trumped by the need to support controls for "backstage access" but Fit4Life demolishes demarcations between a back or front stage. Successful tracking then should at least allow for the user to present that tracked information in different formats for varying audiences or risk abandonment of the platform [9].

While our underlying argument is that the encroachment of such structured systems is far from ideal, our preference is that designers allow users enough space for reflection in order to make such distinctions themselves. Fit4Life continually points out to users when to reduce intake or increase expenditure (of calories, of structure) but our hope is that through discussion, an appreciation of how these issues can be raised without forcing action, negative comparisons, or triggering neuroses can be achieved. Fit4Life's earpiece may be a monologue, but it should be viewed as encouraging a conversation about the system's interpretation of the user. Is the user just a combination of measurable attributes: caloric intake, height and body fat?

CONCLUSION

Our goal in this paper is to provoke discussion of the conceptual and ethical limits of persuasive computing. Our method was to take documented principles and guidelines from the persuasive computing literature and push them to their logical conclusion, in order to clarify some of the dangers that may be involved with them. With Fit4Life, we aimed to make explicit the values that inform the weight management and tracking tools that we have surveyed. By bringing these issues—the idea that sensors accurately measure attributes that directly translate to health; that health can be measured in a purely reductive way; that communal support is always positive—to the surface, we hope that designers will consider how they ask users to conceive of their own health. We highlighted three resulting critical issues for persuasive computing: the extent to which persuasion can shade into coercion; the mutually reinforcing relationship between persuasive computing and broader cultural trends towards scientific rationalization and an "irrationality of rationality;" and issues around surveillance and the ascendancy of data collection over personal experience as a means for establishing truth and manipulating behavior.

One postulate that underlies persuasive computing is that technology is not neutral; it is always guiding the individual. When designers make decisions about the "one right way" that should drive suggestions to influence the "flawed" user, it removes agency from the individual. We embodied Fit4Life with these design habits in an effort to provoke discussion about when and whether this approach is respectful of the user and their ability to interpret. If Fit4Life were designed to foster mindfulness, it might not discuss calories, schedules, and exercise in minutes at all.

The realization of the Fit4Life system brings to the foreground what it means to be human. The reduction of human experience to inputs and outputs raises the questions: am I man or machine? Am I what I eat?

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REFERENCES

1. Institute of Medicine. (1995). Weighing the Options: Criteria for Evaluating Weight-Management Programs.

P.R. Thomas (Ed.). Washington, DC: National Academies Press.

2. National Center for Health Statistics. (2008). Prevalence of overweight, obesity and extreme obesity among adults: United States, trends 1960-62 through 2005-2006. Retrieved from http://www.cdc.gov/nchs/data/hestat/overweight/overweight_adult.pdf.
3. Office of the Surgeon General. (2002). Overweight and Obesity Health Consequences. Retrieved from http://www.surgeongeneral.gov/topics/obesity/calltoaction/fact_consequences.htm.
4. O. Amft, M. Stager, P. Lukowicz, G. Troster. (2005). Analysis of Chewing Sounds for Dietary Monitoring. In *Proc. UBICOMP '05*.
5. O. Amft., G. Tröster. (2009). On-Body Sensing Solutions for Automatic Dietary Monitoring. *IEEE Pervasive Computing*.
6. P.M. Aoki, A. Woodruff. (2005). Making space for stories: ambiguity in the design of personal communication systems. In *Proc. CHI '05*.
7. A.J. Bernheim-Brush, T. Combs-Turner, M. Smith, N. Gupta. (2004). Scanning Objects in the Wild: Assessing an Object-Triggered Information System. In *Proc. UBICOMP '04*.
8. C.L Bish, H.M. Blanck, M.K. Serdula et al. (2005). Diet and physical activity behaviors among Americans trying to lose weight: 2000 Behavioral Risk Factor Surveillance System. *Obes Res*, 13(3):596-607.
9. S. Consolvo, D. McDonald, J. Landay. (2009). Theory-driven design strategies for technologies that support behavior change in everyday life. In *Proc. CHI '09*.
10. A. Dunne, F. Raby. *Design Noir: The Secret Life of Electronic Objects*. Basel:Birkhäuser, 2001.
11. K.E. Evers, J.M. Prochaska, J.O. Prochaska. (2003). Strengths and Weaknesses of Health Behavior Change Programs on the Internet. *J Health Psychol*, 8(1):63-70.
12. G. Eysenbach. (2003). The Impact of the Internet on Cancer Outcomes. *CA Cancer J Clin*, 53(6):356-371.
13. K.M. Flegal, M.D. Carroll, R.J. Kuczmarski, C.L. Johnson. (1998). Overweight and obesity in the United States: prevalence and trends. *Int J Obes Relat Metab Discord*, 22(1):39-47.
14. B.J. Fogg. (2003). Persuasive Technology: Using Computers to Change What We think and Do. San Francisco: Morgan Kaufmann.
15. D.M. Garner, S.C. Wooley. (1991). Confronting the failure of behavioral and dietary treatments for obesity. *Clin Psychol Rev*, 11(6):729-780.
16. B. Gaver, H. Martin. (2000). Alternatives: exploring information appliances through conceptual design proposals. In *Proc. CHI '00*, 209-216.
17. A. Grimes, D. Tan, D. Morris. (2009). Toward technologies that support family reflections on health. In *Proc. GROUP '09*.
18. S. Heshka, J.W. Anderson, R.L. Atkinson et al. (2003). Weight Loss With Self-help Compared With a Structured Commercial Program: A Randomized Trial. *J Amer Med Assoc*, 289(14):1792-1798.
19. R.W. Jeffery, A. Drewnowski, L.H. Epstein, A.J. Stunkard, G.T. Wilson, R.R. Wing. (2000). Long-Term Maintenance of Weight Loss: Current Status. *Health Psychol*, 19(1):5-16.
20. R.W. Jeffery, R.R Wing, C. Thorson, L.R. Burton, C. Raether, J. Harvey, M. Mullen. (1993). Strengthening Behavioral Interventions for Weight Loss: A Randomized Trial of Food Provision and Monetary Incentives. *J Consult Clin Psyc*, 61(6):1038-1045.
21. J.L. Jespersen, A. Albrechtslund, P. Ohrstrom, P. Hasle, J. Albretsen. (2007). Surveillance, Persuasion, and Panopticon. In *Proc. PERSUASIVE '07*, 109-120.
22. D. Kim, Y. Kim, J. Amsden, B. Panilaitis, D.L. Kaplan, F.G. Omenetto, M.R. Zakin, J.A. Rogers. (2009). Silicon electronics on silk as a path to bioresorbable, implantable devices. *Appl Phys Lett*, 95:133701.
23. T. Liacas. 101 Tricks to Play with the Mainstream. In A. Langlois, F. Dubois, eds., *Autonomous Media: Activating Resistance & Dissent*. Montreal: Cumulus Press, 2005, pp. 60-73.
24. L. Mamykina, E. Maynatt, P. Davidson, D. Greenblatt. (2008). MAHI: Investigation of social scaffolding for reflective thinking in diabetes management. In *Proc. CHI '08*, 5-10.
25. H. Oinas-Kukkonen and M. Harjumaa. (2008). A Systematic Framework for Designing and Evaluating Persuasive Systems. In *Proc. PERSUASIVE '08*, 164-176.
26. H. Oinas-Kukkonen and M. Harjumaa. (2009). Persuasive Systems Design: Key Issues, Process Model, and System Features. *Commun Assoc Inform Syst*, 24(1).
27. G. Ritzer. (2004). The McDonaldization of society. Pine Forge Press.
28. D.F. Tate, R.R. Wing, R.A. Winett. (2001). Using Internet Technology to Deliver a Behavioral Weight Loss Program. *J Amer Med Assoc*, 285(9):1172-1177.
29. K. Torning, H. Oinas-Kukkonen. (2009). Persuasive system design: state of the art and future directions. In *Proc. PERSUASIVE '09*.
30. A.G. Tsai, T.A. Wadden. (2005). Systematic Review: An Evaluation of Major Commercial Weight Loss Programs in the United States. *Ann of Intern Med*, 142(1):56-66.