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Persuasive Systems Design: Key Issues, Process Model, and System Features

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Abstract:

A growing number of information technology systems and services are being developed to change users' attitudes or behavior or both. Despite the fact that attitudinal theories from social psychology have been quite extensively applied to the study of user intentions and behavior, these theories have been developed for predicting user acceptance of the information technology rather than for providing systematic analysis and design methods for developing persuasive software solutions. This article is conceptual and theory-creating by its nature, suggesting a framework for Persuasive Systems Design (PSD). It discusses the process of designing and evaluating persuasive systems and describes what kind of content and software functionality may be found in the final product. It also highlights seven underlying postulates behind persuasive systems and ways to analyze the persuasion context (the intent, the event, and the strategy). The article further lists 28 design principles for persuasive system content and functionality, describing example software requirements and implementations. Some of the design principles are novel. Moreover, a new categorization of these principles is proposed, consisting of the primary task, dialogue, system credibility, and social support categories.

Keywords: socio-technical system, behavioral outcomes, system features, development approach, conceptual research, persuasive technology

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I. INTRODUCTION

Interactive information technology designed for changing users' attitudes or behavior is known as persuasive technology [Fogg 2003]. Traditionally, persuasion has meant "human communication designed to influence the autonomous judgments and actions of others" [Simons et al. 2001]. The Web, Internet, mobile, and other ambient technologies create opportunities for persuasive interaction, because users can be reached easily. In addition, the Web and other Internet-based systems are optimal for persuasive communication, because they are able to combine the positive attributes of interpersonal and mass communication [Cassell et al. 1998]. There are certain areas where persuasive technology could be especially useful. For example, healthcare software applications may be developed to motivate people toward healthy behavior, and thereby possibly delay or even prevent medical problems as well as ease the economic situation in public healthcare [Intille 2003; Kraft et al. 2009].

Persuasive systems may be defined as "computerized software or information systems designed to reinforce, change or shape attitudes or behaviors or both without using coercion or deception" [Oinas-Kukkonen and Harjumaa 2008]. In this definition, there are three potential successful outcomes for a persuasive system: the voluntary *reinforcement*, *change* or *shaping* of attitudes and/or behaviors. A reinforcing outcome means the reinforcement of current attitudes or behaviors, making them more resistant to change. A changing outcome means changes in a person's response to an issue, e.g. to social questions. A shaping outcome means the formulation of a pattern for a situation when one does not exist beforehand. In many cases, communication that results in a shaping outcome may have a higher likelihood of success than communication that aims at a changing outcome [Lerbinger 1972]. Moreover, different goals may imply the use of differing persuasion strategies and techniques.

Persuasive systems may utilize either computer-human persuasion or computer-mediated persuasion [Oinas-Kukkonen and Harjumaa 2008]. Admittedly, the concept of a persuader is relatively complex with computer-human persuasion. As computers do not have intentions of their own, those who create, distribute, or adopt the technology are the ones who have the intention to affect one's attitudes or behavior [Fogg 1998]. Although computers cannot communicate in the same way as humans, there are studies that suggest that computer-human persuasion may utilize some patterns of interaction similar to social communication [Nass et al. 1994; Fogg and Nass 1997], whereas computer-mediated persuasion means that people are persuading others through computers, e.g. discussion forums, e-mail, instant messages, blogs, or social network systems.

Despite the fact that attitudinal theories from social psychology have been quite extensively applied to the study of user intentions and behavior, these theories have been developed for predicting user acceptance of the information technology rather than for providing systematic analysis and design methods to develop persuasive software solutions. The widely utilized framework developed by Fogg [2003] provides a useful means for understanding persuasive technology. However, it seems to be too limited to be applied directly to persuasive system development and/or evaluation [Harjumaa and Oinas-Kukkonen 2007]. This article, in spite of being conceptual and theory-creating by its nature, aims at discussing the process of developing and evaluating persuasive systems as well as describing what kind of content and software functionality may be found at the final product. The framework suggested in this article, the Persuasive Systems Design (PSD) model, is based upon our empirical work and conceptual analysis as well as other research.

The development of persuasive systems consists of three steps. See Figure 1 for an illustration of the development process. First, it is crucial to understand the fundamental issues behind persuasive systems before implementing the system. Only after obtaining a reasonable level of this understanding can the system be analyzed and designed. At the second phase, the context for persuasive systems needs to be analyzed, recognizing the intent, event, and strategies for the use of a persuasive system. Finally, actual system qualities for a new information system may be designed or the features of an existing system may be evaluated.

These steps provide the structure for this article. Section II will define the underlying assumptions behind persuasive systems. Section III will discuss how the persuasion context may be analyzed. Section IV will define and describe various techniques for designing the content and functionality of a persuasive system. Section V will provide an example of how to use the framework. Section VI will provide the conclusions of the article.

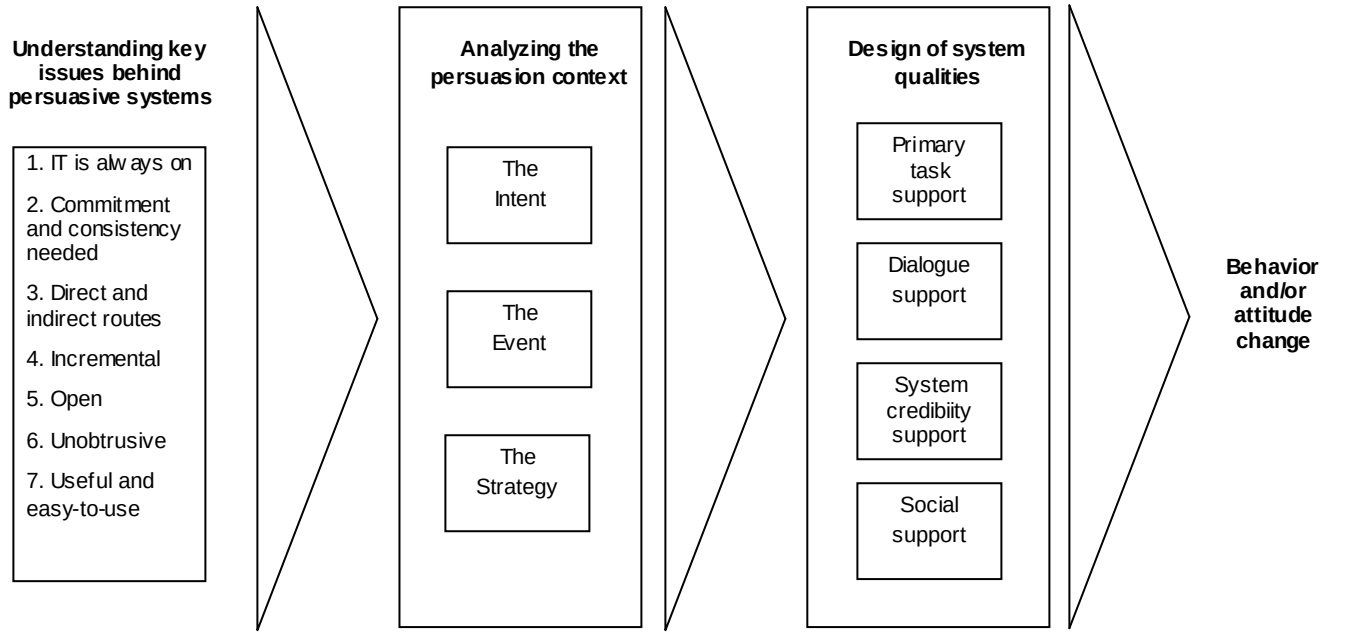

Figure 1. Phases in Persuasive Systems Development

II. KEY ISSUES BEHIND PERSUASIVE SYSTEMS

Based upon our empirical work and conceptual analysis, as well as other research, we define seven postulates that need to be addressed when designing or evaluating persuasive systems. Two of these postulates relate to how we see the users in general, two of the postulates relate to persuasion strategies, and three of the postulates address actual system features. See Table 1 for a summary of the postulates.

Table 1. Postulates behind Persuasive Systems	
1.	Information technology is never neutral.
2.	People like their views about the world to be organized and consistent.
3.	Direct and indirect routes are key persuasion strategies.
4.	Persuasion is often incremental.
5.	Persuasion through persuasive systems should always be open.
6.	Persuasive systems should aim at unobtrusiveness.
7.	Persuasive systems should aim at being both useful and easy to use.

Our first postulate is that *information technology is never neutral*. Rather it is "always on," influencing people's attitudes and behavior in one way or another. Moreover, people are constantly being persuaded in a manner similar to how teachers persuade students in schools, and there is nothing bad in it in itself. This also means that persuasion may be considered as a process rather than as a single act. Persuading a user is a multi-phased and complex task, and different factors, such as the user's goal, may change during the process. For instance, in the beginning of using a pedometer, a user might simply be interested in the number of steps taken but after using the device for a while (s)he may become more interested in burning calories. Persuasive systems should be able to adapt to these kinds of changes.

The second postulate is that *people like their views about the world to be organized and consistent*. This is based on the idea of commitment and cognitive consistency [Cialdini et al. 1981]. If systems support the making of commitments, users will more likely be persuaded. For example, a user may express greater confidence in his or her decision to exercise regularly after having bought a gym membership card. The idea of commitment also implies that persuasive systems could provide means to make private or public commitments to performing the target behavior. This can be implemented, for example, by offering an easy way to send a text message or email to one's relatives, friends, or colleagues.

Cognitive consistency becomes important, because inconsistency may motivate attitude change [Simons et al. 2001]. Psychological inconsistency disturbs people, and they easily want to reorganize their thinking and restore consistency, perhaps even feel obliged to do so. Inconsistency may exist between attitudes and behavior, attitudes toward other people, attitudes toward objects and other people's attitudes toward the same objects [Simons et al. 2001]. The inconsistency must be represented and brought to the attention of the receiver. If a person finds the

inconsistency unpleasant, (s)he will accept personal responsibility for it, and then cognitive dissonance will occur. The dissonance has to be powerful enough, however, to motivate the person to engage in an attitude or behavior change in order to restore cognitive consistency [Fraser et al. 2001]. The idea of cognitive consistency, admittedly, is subject to criticism. Philosophically, people are not fully consistent in their actions and have to deal with minor inconsistencies every day. People also have to feel commitment before inconsistency creates dissonance. For example, if one feels that (s)he could reverse a decision at any time, (s)he is unlikely to experience dissonance. Furthermore, in many cases, if one believes that (s)he has no other choice but to behave inconsistently, (s)he may live with the dissonance. Still, the idea of cognitive consistency can be used in persuasive designs in many ways, for example by offering information to a user that is inconsistent with his or her thinking. Should the behavior change, it will cause an inconsistency between one's attitudes and one's behavior and after a while (s)he may change his or her attitudes to better correspond with the behavior.

The third postulate states that *direct and indirect routes are key persuasion strategies* [Oinas-Kukkonen and Harjumaa 2008]. An individual who carefully evaluates the content of the persuasive message may be approached by the direct route, whereas an individual who is less thoughtful and uses simple cues or stereotypes for evaluating the information may be persuaded through the indirect route. Direct and indirect processes may act simultaneously, and both strategies may be supported through numerous software system features. Direct persuasion has turned out to be the more enduring of the two [McGuire 1973; Petty and Cacioppo 1986]. However, in the era of information overflow, people are often forced to use indirect cues more often than before, because of the abundance of information to be handled. When an individual sees relevant cues, heuristics are triggered. These may also be called *cognitive shorthands*, shortcuts, or rules of thumb. Heuristics are normally derived from experience and may have some empirical validity. Heuristics are often socially shared, but in practice a heuristic is available only if there is a stored representation of it in one's memory [Todorov et al. 2002]. This postulate implies that a user's personal background and the use situation have an influence on his or her information processing. When the user has a high motivation and a high ability, (s)he is more likely interested in the content of the persuasive message than when (s)he has a low motivation and a low ability. In challenging situations such as being in a hurry, it is highly likely that one will use heuristics for processing the information.

The fourth postulate states that *persuasion is often incremental*. In other words, it is easier to initiate people into doing a series of actions through incremental suggestions rather than a one-time consolidated suggestion [Mathew 2005]. This implies that a persuasive system should enable making incremental steps toward target behavior. For example, an application for healthier eating habits could first encourage users to eat at least some vegetables at their meals whereas the system could later suggest filling half of the plate with vegetables. Oftentimes, a system should also encourage users to make an immediate decision rather than postponing it for a later occasion. For example, Web sites for alcoholics could first provide stories from people who have suffered bad consequences, such as memory problems or brain damages, because of alcohol abuse and then encourage the user to make or keep a firm decision to abstain from alcohol use. From the ethical point of view, it is necessary that the overall goal is made clear at all steps of incremental persuasion.

The fifth postulate is that *persuasion through persuasive systems should always be open*. It is very important to reveal the designer bias behind of the persuasive system. For instance, simulations may bear great persuasive power, but if the designer bias remains unclear for the users the simulations may either lose some of their persuasiveness or they may end up misleading their users. Moreover, content that is based on untruthful or false information does not fit with the overall goal of users' voluntarily changing attitudes or behaviors.

The sixth postulate states that *persuasive systems should aim at unobtrusiveness*, i.e. they should avoid disturbing users while they are performing their primary tasks with the aid of the system. In this manner, the system is capable of fulfilling users' positive expectations. The principle of unobtrusiveness also means that the opportune (or inopportune) moments for a given situation should be carefully considered. The use of persuasive features at improper moments, e.g. a heart rate monitor suggesting one to exercise when being sick or getting a reminder to take medication for high blood pressure while giving a presentation at a meeting, may result in undesirable outcomes.

According to the seventh postulate, *persuasive systems should aim at being both useful and easy to use*, i.e. at really serving the needs of the user. This includes a multitude of components, such as responsiveness, ease of access, lack of errors, convenience, and high information quality, as well as positive user experience, attractiveness, and user loyalty. Quite understandably, if a system is useless or difficult to use, it is unlikely that it could be very persuasive. It should be noted, however, that the abovementioned aspects are general software qualities and not specific to persuasive systems only.

III. PERSUASION CONTEXT

Analyzing the persuasion context requires a thorough understanding of what happens in the information processing event, namely understanding the roles of persuader, persuadee, message, channel, and the larger context [Oinas-Kukkonen and Harjumaa 2008]. Persuasive communication produces a complicated psychological event in a person's mind. Basically, the one being persuaded (persuadee), that is the user, is a human information processor [McGuire 1973]. This information processing view emphasizes the role of attention and comprehension in the persuasion process. In order for a person to be persuaded, information must be presented, and the persuadee must pay attention to the argument(s) presented and comprehend it. After this, the persuadee often yields to the position presented and retains it (at least for some time), but in a successful persuasion the persuadee takes action to comply with the new position [McGuire 1973].

In some cases, it is more fruitful to explain the persuasion context through the idea of cognitive consistency. This view differs from the one proposed by McGuire [1973], since he regards the cognitive consistency theory and the information processing approach as mutually exclusive. The idea of cognitive consistency implies that sometimes behavior change may be possible without systematically going through all information processing phases. Nevertheless, persuasion-in-full occurs only when attitude change takes place. Changing a previous attitude is harder than originating or reinforcing an attitude. Furthermore, if a user's existing attitudes are based on his/her personal experience (sometimes learned through a long socialization process), they are harder to change. In proportion, if a user's existing attitudes are recently learned from other people, they are easier to change [Lerbinger 1972].

Without carefully analyzing the persuasion context, it will be hard or even impossible to recognize inconsistencies in a user's thinking, discern opportune and/or inopportune moments for delivering messages, and effectively persuade. This context analysis includes recognizing the intent of the persuasion, understanding the persuasion event, and defining and/or recognizing the strategies in use. See Figure 2.

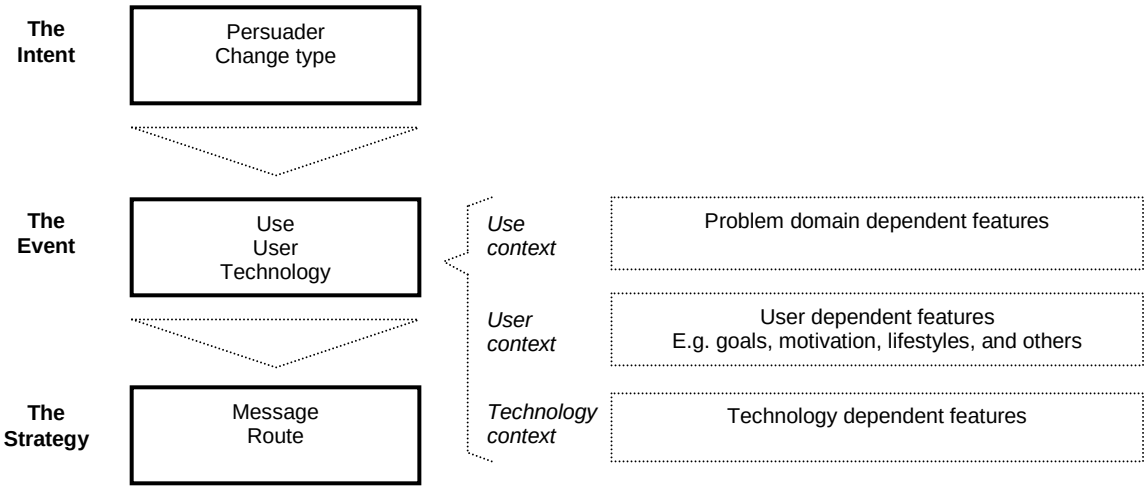

Figure 2. Analyzing the Persuasion Context

The Intent

A serious consideration is needed to determine who is the *persuader*. As computers do not have intentions of their own, those who create, distribute, or adopt the technology have the intention to affect someone's attitudes or behavior. Fogg [1998] has recognized three different sources of intentions: Those who create or produce the interactive technology (endogenous); those who give access to or distribute the interactive technology to others (exogenous); and the very person adopting or using the interactive technology (autogenous). Autogenous technologies that people use to change their own attitudes or behaviors should emphasize that the user experience is rewarding enough for users to keep using the technology regularly over an extended period of time [Nawyn et al., 2006]. Exogenous technologies should provide means to personalize the assigned goals, because their effects are mediated by self-set goals that people choose in response to the assignment, even in organizational settings [Locke and Latham;, 2002]. Endogenous technologies should always be designed with respect to users' voluntariness toward attitude or behavior change. They should reveal the designer bias behind the system (cf. the fifth postulate in Section ii2 of this article).

A central feature of analyzing the intent is to consider the *change type*, in particular whether the persuasion aims at *attitude and/or behavior change*. One-time behavior change may be achieved more easily, whereas permanent

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behavior change is much more difficult. An attitude change that directs behavior may be the most difficult to achieve. Attitudes can vary in many ways. They may be based on emotions, beliefs, or past experiences and behaviors, and they may be internally consistent or ambivalent [Petty and Wegener 1998]. Attitude change means that a person's evaluation is modified from one value to another. In our view, attitudes do not always predict or determine behavior. It is also possible to affect users' behavior with a persuasive system even if their attitudes toward the behavior are not favorable. This is supported by the theory of cognitive consistency. This theory suggests that one can often proceed more efficiently from behavior to attitudes [McGuire 1973]. If the behavior changes first, for example by legal constraints, it may be expected that the attitude change will follow.

There are also other theories which suggest that certain rules or conditions can be defined under which attitudes predict behavior. For instance, the theory of reasoned action, which aims at explaining volitional behavior, suggests that the strongest predictor of behavior is one's intention towards it [Fishbein and Ajzen 1975]. Intentions are a function of attitudes toward modes of behavior and subjective norms. Thus, this theory suggests that a person's attitudes toward behavior and subjective norms indicate how that person will behave in a situation. The attitude toward the behavior and subjective norms are the key elements in attitude change, because in order to change the behavior, the intention to perform that behavior should be influenced. These elements can be changed most effectively by influencing primary beliefs [Fishbein and Ajzen 1975]. The theory of reasoned action is widely used in information systems research for predicting user intentions and user behavior. Davis [1989] has employed it to create the widely used individual human technology acceptance model.

The Event

A central facet analyzing the persuasion event is to consider the *use context*, in particular, the features arising from the problem domain. For instance, many persuasive systems have been developed for promoting health and well-being. It is characteristic of these applications that users often have the necessary information to act and, in many cases, they even have the proper attitudes, but they have problems in behaving in line with them. Bad habits or inappropriate behaviors have often been learned over a long period of time. For instance, addiction, whether physical, emotional, or social, may be a result of lengthy or heavy use of alcohol, nicotine, or other substances. In these cases, persuasive systems should aim at reinforcing proper attitudes and making them easier to stick with even in challenging, spontaneous situations.

In parallel with understanding the use context, the *user context* also needs to be analyzed. People have individual differences which influence their information processing. For example, some people have a high need for cognition whereas some have a low need for cognition. This is based on an individual's tendency to engage in and enjoy effortful cognitive endeavors [Cacioppo and Petty 1984]. A user's need for cognition has an influence on the persuasion strategy that will be successful. People who have a high need for cognition tend to follow the direct route to persuasion [Petty and Wegener 1998]. In addition to relatively straightforward information processing situations, such as learning, users may be approached through larger contexts in their lives, such as a middle-age crisis or the loss of a loved one. Whereas use analysis basically only focuses on the question of what information is relevant for a user in a given situation, the user may be approached in a more holistic manner as well. This context analysis in-the-large means analyzing a user's interests, needs, goals, motivations, abilities, pre-existing attitudes, commitment, consistency, compromises, life styles, persistence of change, cultural factors, deep-seated attitudes, social anchors, and perhaps even the whole personality.

One of the most essential facets of analyzing the user context is understanding the user's goals, including current progress toward achieving them, and potentially past performances. Users' goals and intentions can be studied from various perspectives. In their theory of reasoned action, Fishbein and Ajzen [1975] have discussed discrete intentions to take specific actions. In their theory of goal setting, Locke and Latham [2002] have focused on the relationship between conscious performance goals and the level of task performance. The goal-setting theory acknowledges the importance of conscious goals and self-efficacy, focusing on the core properties of an effective goal and on the motivation for work settings.

The goal setting theory [Locke and Latham 2002] explains that goals affect performance through directing attention and effort (toward goal-relevant activities and away from goal-irrelevant activities), energizing (high goals lead to greater effort than low goals), persistence (hard goals prolong effort, and tight deadlines lead to more rapid work pace than loose deadlines), and by leading to arousal and/or use of task-relevant knowledge and strategies. This theory states that (a) the highest and most difficult goals produce the highest levels of effort and performance; (b) specific, difficult goals consistently lead to higher performance than urging people to do their best; (c) when goals are self-set, people with high self-efficacy set higher goals than do people with lower self-efficacy; and (d) people with high self-efficacy are also more committed to the assigned goals and to finding and using better task strategies to attain the goals as well as to responding more positively to negative feedback. Thus, when users have the opportunity to set a goal, they will use their preexisting knowledge and earlier experience more effectively to achieve

their goals. Overall, persuasive systems should encourage users to set goals and to discover ways for achieving them in a systematic and effective way. It should be noted, however, that goal specificity in itself does not necessarily lead to high performance.

In computer-human and computer-mediated persuasion, the *technology context* also plays an important role. Information technologies are being developed with a great speed and new technologies become available rapidly. The strengths and weaknesses, as well as the risks and opportunities, of specific technological platforms, applications and features need to be thoroughly understood.

The Strategy

A central feature for defining persuasion strategies is analyzing the *message*. A persuasion situation may be defined as an event in which the persuadee makes optimal compromises among conflicting forces [McGuire 1973]. This view has been criticized by Cialdini et al. [1981], because it emphasizes the rational processing of arguments. Nevertheless, this is a relatively large part of the whole picture of persuasion. Since persuasion may also be described as changing the attitudes and/or behavior of others, the persuader is often trying to convince the persuadee of something. Drawing the line between convincing and persuasion is difficult. Persuasion relies primarily on symbolic strategies that trigger the emotions, whereas conviction relies on strategies rooted in logical proof and appeals to persuadees' reason and intelligence [Miller 2002].

The second central question in defining persuasion strategies is considering the proper *route* to be used in reaching the user, in particular whether to choose a *direct or indirect* route for persuasion. Direct and indirect processes may act simultaneously, and both strategies may be supported through numerous software system features. The route selection depends on the user's potential to carefully evaluate the content of the persuasive message. If (s)he is able to do that, a direct route could be used. In many cases, this is advisable since direct persuasion has turned out to be the more enduring of the two [McGuire 1973; Petty and Cacioppo 1986]. In these cases, persuasion basically aims at convincing the user by appealing to reason and intelligence. However, in the era of information overflow people are often forced to use indirect cues more often than before, because of the abundance of information to be handled. An individual who is less thoughtful and uses simple cues or stereotypes for evaluating the information may be persuaded through the indirect route. When an individual sees relevant cues, heuristics are triggered.

IV. DESIGN OF SYSTEM FEATURES

Fogg's [2003] functional triad and the design principles presented in it constitute the first and so far most utilized conceptualization of persuasive technology. A weakness of this model is that it does not explain how the suggested design principles can and should be transformed into software requirements and further implemented as actual system features. Yet, to be able to design and evaluate the persuasiveness of a software system, it becomes essential to understand both the information content and the software functionalities. Nevertheless, many of the design principles described below have been adopted and modified from Fogg [2003].

Requirements specification is one of the most important phases in software development. It covers the activities involved in discovering, documenting, and maintaining a set of requirements for the computer-based information system that will be designed and developed [Sommerville and Sawyer 1997]. Requirements are descriptions of how the system should behave (functional requirements), qualities it must have (nonfunctional requirements), and constraints on the design and development processes [Sommerville and Sawyer 1997; Robertson and Robertson2006]. A system's persuasiveness is mostly about system qualities.

The presented postulates already implicitly cover a multitude of aspects that need to be recognized when designing persuasive systems, including responsiveness, error-freeness, ease of access, ease of use, convenience, information quality, positive user experience, attractiveness, user loyalty, and simplicity, to name a few; however, more precise requirements for software qualities will have to be defined to be able to communicate the ideas from idea generators and/or management to software engineers. Similarly, in evaluating persuasive systems, software quality checklists will needed. The three steps necessary to make an idea become reality are summarized in Figure 3.

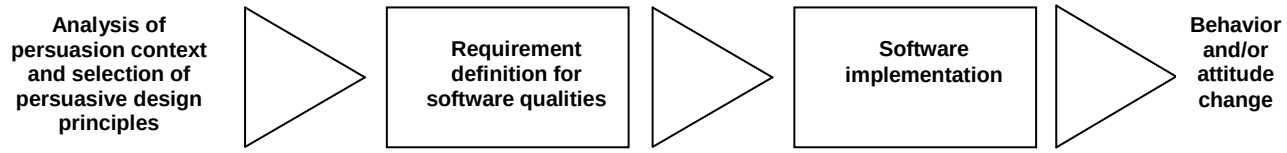

Figure 3. Generic Steps in Persuasive System Development

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The categories for persuasive system principles suggested in this article are primary task, dialogue, system credibility, and social support.

The design principles in the primary task category support the carrying out of the user's primary task. The design principles in this category are reduction, tunneling, tailoring, personalization, self-monitoring, simulation, and rehearsal. See Table 2.

Table 2. Primary Task Support

Principle	Example requirement	Example implementation
Reduction A system that reduces complex behavior into simple tasks helps users perform the target behavior, and it may increase the benefit/cost ratio of a behavior.	System should reduce effort that users expend with regard to performing their target behavior.	Mobile application for healthier eating habits lists proper food choices at fast food restaurants [Lee et al. 2006]. Smoking cessation Web site provides an interactive test that measures how much money a user will save with quitting.
Tunneling Using the system to guide users through a process or experience provides opportunities to persuade along the way.	System should guide users in the attitude change process by providing means for action that brings them closer to the target behavior.	Smoking cessation Web site offers information about treatment opportunities after a user has taken an interactive test about how addicted (s)he is on tobacco.
Tailoring Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group.	System should provide tailored information for its user groups.	Personal trainer Web site provides different information content for different user groups, e.g. beginners and professionals. Web site for recovering alcoholics presents stories that are close to the user's own story.
Personalization A system that offers personalized content or services has a greater capability for persuasion.	System should offer personalized content and services for its users.	Arguments most likely to be relevant for the user presented first on a professional Web site rather than in random order.
Self-monitoring A system that keeps track of one's own performance or status supports the user in achieving goals.	System should provide means for users to track their performance or status.	Heart rate monitor presents a user's heart rate and the duration of the exercise. Mobile phone application presents daily step count [Consolvo et al. 2006].
Simulation Systems that provide simulations can persuade by enabling users to observe immediately the link between cause and effect.	System should provide means for observing the link between the cause and effect with regard to users' behavior.	Before-and-after pictures of people who have lost weight are presented on a Web site.
Rehearsal A system providing means with which to rehearse a behavior can enable people to change their attitudes or behavior in the real world.	System should provide means for rehearsing a target behavior.	A flying simulator to help flight pilots practice for severe weather conditions.

Any interactive system provides some degree of system feedback to its users, potentially via verbal information or other kinds of summaries. There are several design principles related to implementing computer-human dialogue support in a manner that helps users keep moving towards their goal or target behavior. They include praise, rewards, reminders, suggestion, similarity, liking, and social role. See Table 3.

Table 3. Dialogue Support

Principle	Example requirement	Example implementation
Praise By offering praise, a system can make users more open to persuasion.	System should use praise via words, images, symbols, or sounds as a way to provide user feedback information based on his/her behaviors.	Mobile application that aims at motivating teenagers to exercise praises user by sending automated text-messages for reaching individual goals. [Toscos et al. 2006]
Rewards Systems that reward target behaviors may have great persuasive powers.	System should provide virtual rewards for users in order to give credit for performing the target behavior.	Heart rate monitor gives users a virtual trophy if they follow their fitness program. Game rewards users by altering media items, such as sounds, background skin, or a user's avatar according to user's performance. [Sohn and Lee 2007]
Reminders If a system reminds users of their target behavior, the users will more likely achieve their goals.	System should remind users of their target behavior during the use of the system.	Caloric balance monitoring application sends text-messages to its users as daily reminders. [Lee et al. 2006]
Suggestion Systems offering fitting suggestions will have greater persuasive powers.	System should suggest that users carry out behaviors during the system use process.	Application for healthier eating habits suggests that children eat fruits instead of candy at snack time.
Similarity People are more readily persuaded through systems that remind them of themselves in some meaningful way.	System should imitate its users in some specific way.	Slang names are used in an application which aims at motivating teenagers to exercise. [Toscos et al. 2006]
Liking A system that is visually attractive for its users is likely to be more persuasive.	System should have a look and feel that appeals to its users.	Web site that aims at encouraging children to take care of their pets properly has pictures of cute animals.
Social role If a system adopts a social role, users will more likely use it for persuasive purposes.	System should adopt a social role.	E-health application has a virtual specialist to support communication between users and health specialists. [Silva et al. 2006]

The design principles in the system credibility category describe how to design a system so that it is more credible and thus more persuasive. The category of system credibility consists of trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability. See Table 4.

The design principles in the social support category describe how to design the system so that it motivates users by leveraging social influence. The design principles that belong into this category are social facilitation, social comparison, normative influence, social learning, cooperation, competition, and recognition. See Table 5.

Table 4. System Credibility Support

Principle	Example requirement	Example implementation
Trustworthiness A system that is viewed as trustworthy will have increased powers of persuasion.	System should provide information that is truthful, fair and unbiased.	Company Web site provides information related to its products rather than simply providing biased advertising or marketing information.
Expertise A system that is viewed as incorporating expertise will have increased powers of persuasion.	System should provide information showing knowledge, experience, and competence.	Company Web site provides information about their core knowledge base. Mobile application is updated regularly and there are no dangling links or out-of-date information.
Surface credibility People make initial assessments of the system credibility based on a firsthand inspection.	System should have competent look and feel.	There are only a limited number of, and a logical reason for, ads on a Web site or mobile application.
Real-world feel A system that highlights people or organization behind its content or services will have more credibility.	System should provide information of the organization and/or actual people behind its content and services.	Company Web site provides possibilities to contact specific people through sending feedback or asking questions.
Authority A system that leverages roles of authority will have enhanced powers of persuasion.	System should refer to people in the role of authority.	Web site quotes an authority, such as a statement by government health office.
Third-party endorsements Third-party endorsements, especially from well-known and respected sources, boost perceptions on system credibility.	System should provide endorsements from respected sources.	E-shop shows a logo of a certificate that assures that they use secure connections. Web site refers to its reward for high usability.
Verifiability Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of site content via outside sources.	System should provide means to verify the accuracy of site content via outside sources.	Claims on a Web site are supported by offering links to other web sites.

Even if the design principles in the primary task support category are based on the works of Fogg [2003], there are also many differences from them. The key benefit of suggestion is meaningful content for the user rather than providing support for carrying out a process or making a task simpler to do. For this reason, it is tackled in the dialogue support category. In our view, surveillance and conditioning are not acceptable means for persuasive systems. Oftentimes people cannot choose whether they may be observed or not, which easily leads to covert approaches. In a similar manner, operant conditioning oftentimes is not open. Moreover, we also think that users act more or less rationally in how they form and modify attitudes, on the basis of beliefs and values rather than performing behavior as a result of conditioning.

The design principles related to dialogue support are partly adopted from Fogg's ideas on social actors (attractiveness, similarity, and praise) and media (virtual rewards). Reminders and social role suggest new design principles, whereas the idea of reciprocity was excluded from this framework because it is a characteristic of a user rather than a system feature.

The differences between the design principles in the system credibility category and the functional triad are that this category excludes the system fulfilling users' positive expectations as well as the ideas of responsiveness, ease-of-use, and error-freeness, because they belong to the postulates. Since personalization is very closely related to

tailoring, it can be found at the primary task category. On the other hand, the key benefit of referring to an authority is to increase system credibility in a manner similar to other principles in this category. Presumed credibility, reputed credibility, and earned credibility influence users, doubtless even more than many of the abovementioned principles much of the time, but since these can not really be represented as system features, they are excluded.

Table 5: Social support

Principle	Example requirement	Example implementation
Social learning A person will be more motivated to perform a target behavior if (s)he can use a system to observe others performing the behavior.	System should provide means to observe other users who are performing their target behaviors and to see the outcomes of their behavior.	A shared fitness journal in a mobile application for encouraging physical activity [Consolvo et al. 2006].
Social comparison System users will have a greater motivation to perform the target behavior if they can compare their performance with the performance of others.	System should provide means for comparing performance with the performance of other users.	Users can share and compare information related to their physical health and smoking behavior via instant messaging application [Sohn and Lee 2007].
Normative influence A system can leverage normative influence or peer pressure to increase the likelihood that a person will adopt a target behavior.	System should provide means for gathering together people who have the same goal and make them feel norms.	A smoking cessation application shows pictures of newborn babies with serious health problems due to the mother's smoking habit.
Social facilitation System users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them.	System should provide means for discerning other users who are performing the behavior.	Users of a computer-based learning environment can recognize how many co-students are doing their assigned homework at the same time as them.
Cooperation A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to co-operate.	System should provide means for co-operation.	The behavioral patterns of overweight patients are studied through a mobile application, which collects data and sends it to a central server where it can be analyzed at the group level in more detail [Lee et al. 2006].
Competition A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to compete.	System should provide means for competing with other users.	Online competition, such as Quit and Win (stop smoking for a month and win a prize).
Recognition By offering public recognition for an individual or group, a system can increase the likelihood that a person/group will adopt a target behavior.	System should provide public recognition for users who perform their target behavior.	Names of awarded people, such as "stopper of the month," are published on a Web site. Personal stories of the people who have succeeded in their goal behavior are published on a smoking cessation Web site.

The design principles in the social support category have been adopted from Fogg's principles on mobility and connectivity. The opportune and inopportune moment and the ideas behind information quality, convenience, and simplicity have been covered in the postulates in other categories.

V. EXAMPLE

In this section, we will demonstrate the feasibility of the suggested conceptual framework through discussing a contemporary, commercial system that incorporates several distinct persuasive techniques in its functionality. The four described functionalities belong to the four different categories.

The Nike+ running system comprises a pair of running shoes with a built-in pocket for a running sensor, an mp3 player or a sport band, and a web service [Nike+ 2008]. See Figure 4. The sensor tracks running information and sends the data to the mp3 player or a special sport band on the runner's wrist. While running, the user can hear summary feedback such as his or her pace, time, distance, and calories burned. After running, the user can download his or her training information to the web service [Nike+ 2008] and see the full run data.

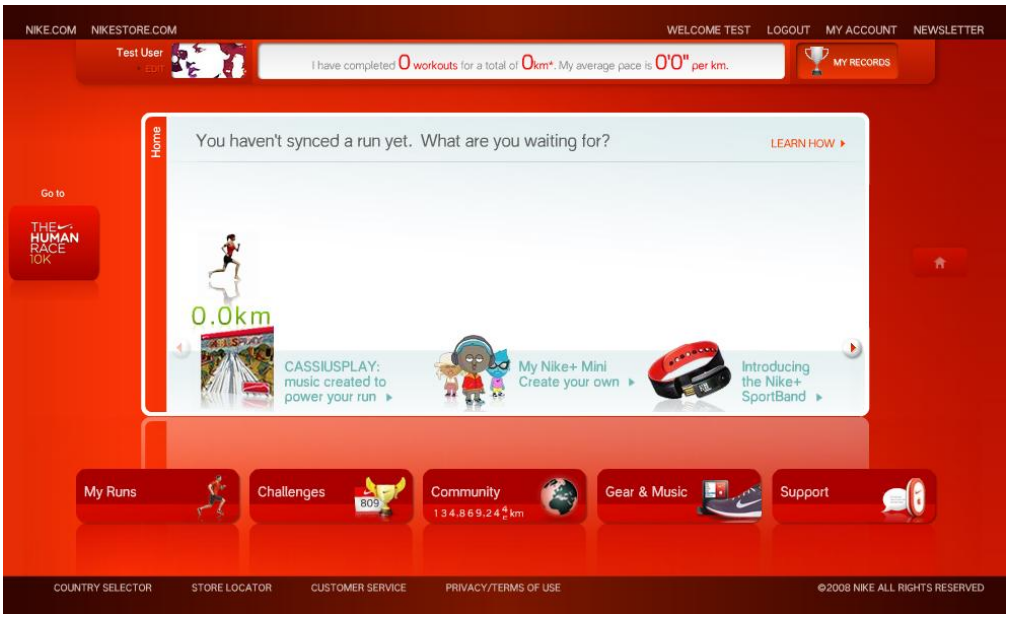

Figure 4. The Nike+ Web Service

The Nike+ system supports users' primary task by reducing the complexity of planning the exercises via suggesting training programs. These have been categorized according to the runner's goals, e.g. "walk to run," "5k," "10k," "half marathon," "marathon," or "build your own." When the build your own feature is selected, the application works like an electronic calendar where the user can add his or her own runs and distances per day. See Figure 5. The system also leverages the principle of personalization by enabling the adding of one's own name and picture to the screen. Naturally, self-monitoring is utilized by providing a means to track the running information.

Figure 5. Leveraging the Reduction Principle: The Creation of a Training Program

The computer-human dialogue is supported by praise and rewards. The user is able to set challenges at individual or team levels. After achieving the goals that have been set, the user receives a reward and the system praises him or her, for instance, by saying “Congratulations! You achieved your goal.” See Figure 6.

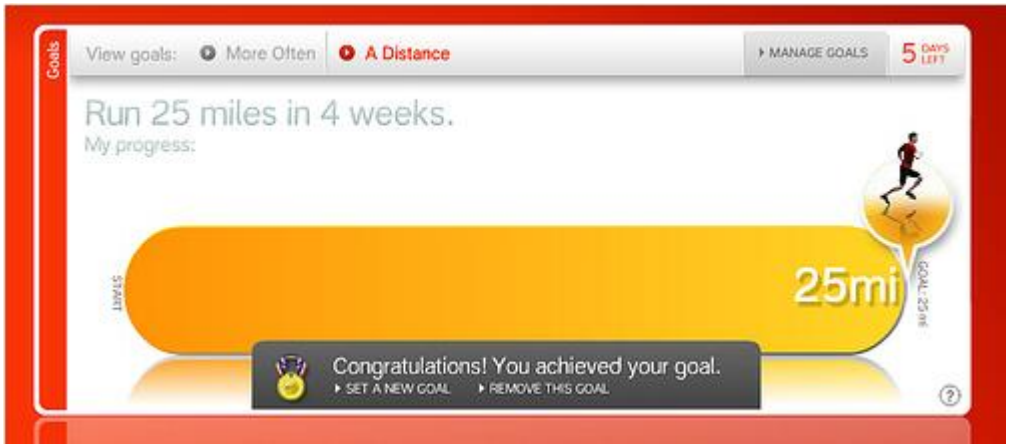

Figure 6. Leveraging Praise and Rewards: The Positive Feedback after Goal Attainment

The system credibility emphasizes expertise behind the system. For instance, when a user tries to create his or her own training program, the system brings its expertise to the fore, suggesting one of its offerings by saying: “Nike+ training programs were exclusively developed by Nike elite trainers for a range of goals and experience levels.” It also uses the expression “coach” with its training program offerings. See Figure 7.

Figure 7. Showing Expertise by Providing Background Information

The system also motivates users by leveraging social support. Besides individual challenges, it provides opportunities to define team challenges. A team goal can be a distance race (e.g. “the first team to run 100 miles”), the most miles (e.g. “the team that runs the most miles in 30 days”), or a distance goal (e.g. “every team has to run 500 miles this season”). See Figure 8. Challenges or goals that are shared by team members are supposed to leverage human beings’ natural drive to cooperate via achieving the goal together. Users may also be influenced by normative influence (i.e. peer pressure) as a consequence of the pressure of achieving one’s own part of the shared goal. Furthermore, the system utilizes other principles from the social support category. An individual user’s profile can be “public” so that all of one’s running data (as well as home towns, “power songs,” usernames, and pictures) will be shared with other users as well. In doing this, the system leverages the principles of social learning by providing means for observing others performing the same behavior and social comparison by offering means for comparing their performance with the performance of others. The system also provides means for public recognition. For instance, there is the fastest run challenge (e.g. “the person with the fastest 5k run by September 30 wins”), in which the winner gets public recognition in front of other runners.

The aforementioned functionalities by no means cover all of the persuasive qualities of the referred system, but they help demonstrate the practicality of the theoretical framework put forth in this article.

Figure 8. Leveraging the Principle of Co-Operation: Creation of a Group Challenge

VI. CONCLUSION

This article has presented a framework for designing and evaluating persuasive systems, known as the Persuasive Systems Design (PSD) model. The underlying postulates behind persuasive systems were defined and the importance for a thorough analysis of the intent, event, and strategy was brought to attention. Although this article is conceptual and theory-creating by its nature, it has practical implications. It was proposed that persuasion principles should be considered mainly as requirements for software qualities. Twenty-eight design guidelines, mostly based on Fogg's functional triad, were defined with software requirement and implementation examples. A new categorization of the principles was based on their key benefits, which makes them more practical for actual systems development. In future research, experimental work will be needed to demonstrate the framework's applicability in various real-life design and usage situations. The suggested postulates, means for analyzing the persuasion context, new categorization, and design principles may become especially useful in motivating and persuading users to reach their own personal goals.

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Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that:

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