ProSPer: modeling the change, driving the persuasion

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ABSTRACT
The development of persuasive interactive systems is typically achieved in an opportunistic way for shipping one persuasive system at a time, thus negatively affecting internal modularity (persuasion concepts are typically mixed up throughout the development life cycle) and reusability (parts or the whole persuasive system is of little reuse for another domain of human activity). In order to address these challenges, this paper introduces, motivates, and defines MOST4P, a Mission-Operation-Strategy-Tactic 4-level model for structuring the development of a persuasive interactive system and ProSPer, a MOST4P-based framework for developing persuasive interactive systems, software-based and/or manual-based that explicitly satisfy modularity (MOST concepts satisfy the separation of concerns) and multiple-domain applicability (MOST concepts could be reused from one domain to another). The paper then reports on a pilot study involving twelve participants evaluating how MOST4P concepts have been used in a self monitoring bracelet and in a mobile ProSPer-based persuasive interactive system. This study suggests that overall subjective satisfaction and usefulness are the most appreciated criteria, followed by interaction and information qualities.

Author Keywords
persuasive interactive systems; engineering of interactive systems; Mission-Objective-Strategy-Tactic (MOST) paradigm; multiple-domain applicability; persuasive models; persuasive interfaces; reusability; separation of concerns.

ACM Classification Keywords
H.5 Information Interfaces and Presentation: User Interfaces, Miscellaneous; J.4 Social and Behavioral Sciences: Psychology, Sociology

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INTRODUCTION

Human beings feel attracted by nature to reach a satisfying physical, mental or social status depending on society, culture and other anthropological factors they are exposed to. Several examples could be cited as success in work and in society, happiness in the private environment, physical wellness or spiritual fulfilment. Reaching such a status in a satisfying way largely depends on the person and his/her contextual factors that may influence how the status is expressed, what level is desired, and what kind of means could be used to reach it. For example, being efficient at work can lead to a desired promotion for a better position or a more socially recognized appearance, having sane relationships foster familial cohesion, performing regular physical activities or eating organic food are proved to contribute to a healthy status.

Reaching such a status by stating various objectives or by involving a genuine process of change in our behaviours, attitudes or habits has been investigated and studied for centuries. For instance, being more efficient may be achieved by arriving earlier at the office, properly sleeping or by avoiding drinking coffee late in the day. These are examples where our behaviour should change to some extent.

Slogans such as "Smoking kills", "Willingness is the key", "There is always a better possibility", or motto for health as "Eat wise, drop a size" could encourage people think about what they could change, but not how they could change. They are insufficient to induce a change that is sustainable over time. Therefore, introducing a constructive process made up of steps from engaging the change, following it, and hopefully maintaining it could contribute to such a change.

Nowadays our life becomes digitized and we rely more frequently on technology for any purpose : taking photos, doing sports, scheduling our activities, eating healthy food, checking what we buy, etc. This trend could be also influenced by the tremendous development of the Internet of Things, which involves these types of devices and their reciprocal connection and data sharing capabilities.

"Persuasive technologies" result from technology meeting behavioral change theories and they are broadly defined as the general class of technology that has the explicit purpose of changing human attitudes and behaviours [7].

Over the last decade, several proposals and research questions related to persuasive interactive systems have been discussed. This paper focuses on two of them : (i) how to give to persuasive interactive systems the capability of describing domain-independent change that the users want to achieve, (ii) how to take advantage of the literature produced insofar to introduce a new paradigm for structuring the development of such systems in order to foster reusability.

In order to address the aforementioned challenges, we divided the work in a first part describing some of the model and design principles we can actually find in the literature with the aim of finding a possible integration in a framework capable of reusing them. Then we will present the MOST4P model (Mission, Objective, Strategy and Tactics) inspired from business analysis, whose models are expected to cover a wide range of potentially heterogeneous application domains (e.g., employees management motivation or productivity, general management, marketing strategies) figuring as a possible solution to describe domain-independent targeted behaviors. We will then propose our ProSPer framework as an extension of MOST4P reorganized into three layers : problem solution and persuasion. In order to validate the applicability of our approach we performed on 12 participants two experiments : the first without any digital environment using a colored string bracelet as self-monitor and engage-reminder, the second involving an Android application prototype implementing all the ProSPer extension layers. Finally along with the findings we will propose prospectives for this work basing on participants' feedback and on the result of our pilot study.

STATE OF THE ART

Behavioral change theories are key in persuasion as they provide models characterizing the changes and dimensions of a change. This paper relies on some fundamental concepts described in these theories. Hence, an overview of these significant theories will help defining, discussing, and understanding various prospectives used to describe the concept of persuasion.

Stages of a change

The ultimate goal of persuasion consists in changing something. This change is not necessarily an instantaneous event but a progression achieved through stages described by well defined personal status. A typical example is the Transtheoretical model theorized by Prochaska and Diclemente[12]. The Transtheoretical model of Behaviour of change is composed of four key constructs : states of change (six), processes of change (ten), decisional balance, and self-efficacy.

The 10 processes of change are "covert and overt activities that people use to progress through the stages" [12]. They take into account the cognitive, affective, and evaluative processes people use to apply through the stages. Decisional balance "reflects the individual's relative weighing of the pros and cons of changing" [12], while the self-efficacy represents "the situation-specific confidence people have that they can cope with high-risk situations without relapsing to their unhealthy or high risk-habit".

Dimensions and social factors related to a change

Persuasion can be described through an analysis concerning the social factors related to the persuasive technology. The Fogg Triad defines three different roles that a persuasive technology can assume from the point of view of the user : the role of tool (e.g., changing the attitude of the user helping him/her to accomplish the result easily), the role of media (e.g., conveys either symbolic content or sensory content) or the role of social actor (e.g., adopting animate characteristics, playing animate roles, or follow social rules or dynamics) [5].

In the Fogg Behaviour Model (FBM) the persuasion is represented through various dimensions characterizing a single user, who may change depending on contextual events or situations in a given context of use. In this model, the change is likely to happen if the target behavior is sufficiently motivated, it has the ability to perform the behavior, and it is triggered to perform the behavior. These three factors must occur and reach a certain threshold simultaneously to trigger an effective change. Otherwise the behavior is likely not to happen [6].

Some specific elements can affect the level of ability and motivation. Elements affecting motivation are central to the human experience and are : Pleasure/Pain, Hope/Fear, Social Acceptance/Rejection. The element that affects ability the most is simplicity, in other words, make the path to a change easier. According to Fogg, simplicity consists of six parts which are related to each other like links in a chain : if any single link breaks, then the complete chain may fail. In this case, simplicity is lost [6]. The six factors making simpler the change and so increasing ability are : time, money, physical effort, brain cycles, social deviance, and non routine.

Behavior change support system

A behavior change support system is defined by Kukkonen as "an information system designed to form, alter or reinforce attitudes, behaviors or an act of complying without using deception, coercion or inducements." [9] In this perspective archetypes of a behavioral change can fit in defined categories as : complying, a behavior change, and an attitude change (C-, B- or A-Change) which can lead to three voluntary outcomes : a forming outcome (formulation of a situation that did not exist before), an altering outcome (a change in the person's response) or to a reinforcing outcome (make the current behavior stronger). [9]. The compiling change simply ensures that the end user complies with the requests of the system. The goal of a system supporting a B-Change is to elicit a more enduring change than simple compliance once or a few times while the goal of a system supporting an A-Change is to influence the end user's attitudes rather than his/her behavior only [9].

The features of a behavior change support system can be designed during the development stage following specific guidelines and principles. In [10] for example, 4 different categories of design principles are considered : primary task support (carrying out of the user's primary task), dialogue support (implementing computer-human dialogue support), system credibility (design a system so that it

is more credible) and social support (design the system so that it motivates users by leveraging social influence). This features has been also used to define the persuasive system design, the PSD model [11]. The model is more oriented to design and take into consideration the notion of context defined as "any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves." [2].

MOST4P MODEL AND PROSPER EXTENSION

MOST stands for Mission (the rationale and direction for the organisation), Objective (the goals that the organisation aims to achieve), Strategy (the medium- to long-term plans and actions that will enable the organisation to achieve its objectives) and Tactics (the detailed, short-term plans and actions that will deliver the strategy) [1]

We have seen how in literature several models has been created to address the challenges of describing or to driving persuasion. We want now to present our MOST4P/ProSPer approach to address those challenges at the same time. To do so we will start explaining the origin of the MOST4P paradigm for Business Analysis. MOST analysis is used to analyse what an organisation has to set out to achieve (the mission and objectives) and how it aims to achieve this (the strategy and tactics). A MOST provides a statement of intent for the organisation, and is usually created following some strategic analysis activity. It is also used during the strategic analysis, since it can demonstrate strength within the organisation or expose inherent weaknesses. [1]

This model has been used in business analysis as a highly-structured method for providing targets to team members. Working from the top down, it ensures the focus retaining on the goals which matter most to a certain organisation.

MOST4P to describe a change

Adapting the statement of Cadle et al. in our prospective results in defining Mission as the final change the person wants to achieve completing a set of Objectives which can be seen as solution steps chosen by the person to move in the direction of the Mission. The strategies are the solutions the person chooses to engage according to his/her own profile while the Tactics refers to the context in which the person decides to apply a given Strategy.

People often would like to change several things in their behavior (as quit smoking or being in shape) and they take advantage of diverse technologies maybe distributed on diverse applications or devices. The modularity of this model instead allows to describe the different Missions a person would like to achieve bringing the idea of change as a compact concept a person could engage, follow and hopefully maintain.[4]

An example scenario of this diversity that can be modelled using this model is described in the following section.

From a scenario to a MOST4P model compilation

Let consider a user called Bill who wants to change some aspects of his life. Bill wants to be in good shape, increase his savings and improve his eclectic consumption since he is an ecological person. For example Bill knows that usually friends and people, in order to be in shape, practice sports, eat healthier and try to avoid addictive behavior as smoking. For this reason, he starts to design a plan involving eating apples when he is in the office during the afternoon, having infusions in late morning but also involving changes in his habits as starting to prepare his food at home instead of going to fast food places where he always ends up eating junk food, and drinking beer.

In this scenario we can find three Missions : "Being in shape", "Increase his saving" and "Improve his electric consumption". In the scenario we just developed the Mission "Being in shape" with the objectives "Doing sports", "Eating healthier" and "Avoid smoking". Developing one of them as "Eating healthier" we can state the following Strategies : "Eating apples" and "Having infusions" which can be applied using a Tactic that reminds him to do that "in the office during the afternoon". Figure 1 represents this example structured on the MOST4P model applied to behavioral change.

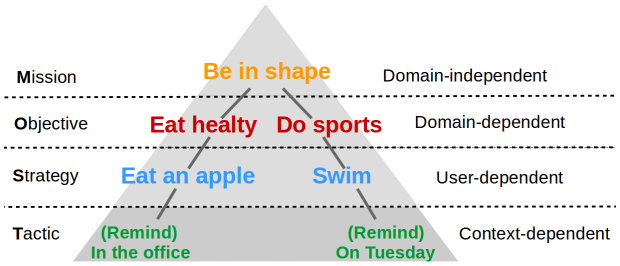

Figure 1. An example of MOST4P applied to behavioral change theories

We can observe that the tactic just proposed implies two different aspects : the first, having a functionality able to "remind" the action (moreover according to the actual stage of the change of the person), the second, be able to detect and take advantage of a given context as the workplace for example, or the actual time of the day.

These two aspects are the foundations of persuasive systems : on one side the literature which provides us of models/functionalities/paradigms to build the interaction with the user, on the other side the context, strictly necessary to drive an effective persuasion. In previous studies it has in fact been proved that driving persuasive elements to users without taking in to account the context can be catastrophic for the success of the mission. For example persuading a smoker to avoid smoking during in the morning can be taken as challenge for the rest of the day, while notifying the same message during the work-time can lead the subject to light on a not even planed cigarette. [3]

We emphasize that a tactic (last level of the pyramid) specifies the context in which the user performs the strategy (a concrete action to change). In this first model the "operational part" is left to users, that choose to apply their strategies according to the personal daily schedule. In ProSPer has an operational approach implemented by the Actions which will be further detailed with concrete examples in the "Persuasion Layer" paragraph.

Implementation

We perform an implementation of the MOST4P using string bracelets representing the model encoded through colour stripes.

Figure 2. MOST4P model implemented on a bracelet

The purpose of the bracelet is to encourage users to react when looking at the bracelet during the day as a self-monitoring strategy.

Even if this prototype may appear very simple and raw it should be considered as a static instantiation of the model. A more dynamic one could be achieved using composable pieces that allows eventually users to change/add/remove items. Figure 2 represents the same example of Figure 1 implemented on a bracelet.

The ProSPer extension

The MOST4P model allows to structure the change that a person could engage, follow and hopefully maintain. Once this definition has been given by the user, the system should be capable of driving the persuasion in order to accompany him/her in the change. Of course this capability is originally present in the MOST4P model, for this reason we defined a new model called ProSPer built on top of the MOST4P model but providing also the instruments to engine and drive persuasion from the system to the user. In order to do that we add a fifth level at the bottom of Tactics and we called them Actions.

We regrouped all into three layers describing the persuasion (persuasion layer) through the definition of solutions (solution layer) for a given problem (problem layer).

These three layers communicate with a transverse sensor layer represented in Figure 3, by some generic symbols to make explicit that it can involve different kinds of sensors as GPS, presence, RFID, and others. The first two layers are related to the structuring of the Problem and Solution in the MOST4P paradigm while the last is responsible for driving the persuasion to the end user.

Figure 3 gives a global overview of the ProSPer framework which appears as a specification of a general mission until the definition of strategies is achieved. The first two layers are user-driven while the last one is system-driven. This difference relies in the fact that The Problem and the Solution layer are compiled by the user, meaning that the definition of the Mission Objective and Strategies follows his/her profile in terms of behavior change s/he targets. The persuasive layer is grounded in the tactics coming from the state of the art in persuasion and the running system

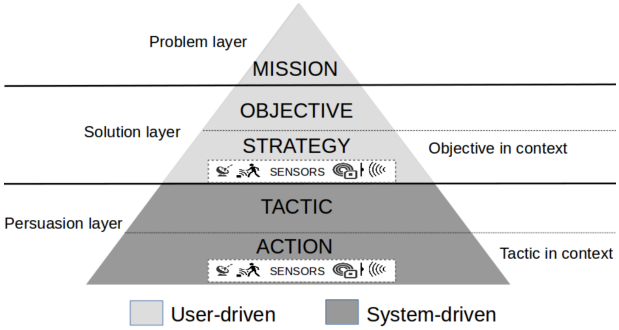

Figure 3. ProSPer Model overview

is in charge of compiling them to persuade the user. The persuasive layers take both the information about the user strategies and the context of use to provide tactics and actions to drive a persuasive solution for the mission. The context as we already anticipated plays a key role in the model : the sensors take the objectives and instantiate them into strategies that are ready to be performed. Similarly, in the persuasive layer the action can be defined as tactics in context thanks to the data provided by the sensors.

Figure 4 illustrates an updated version of the example in Figure 1, taking advantages of the ProSPer capabilities.

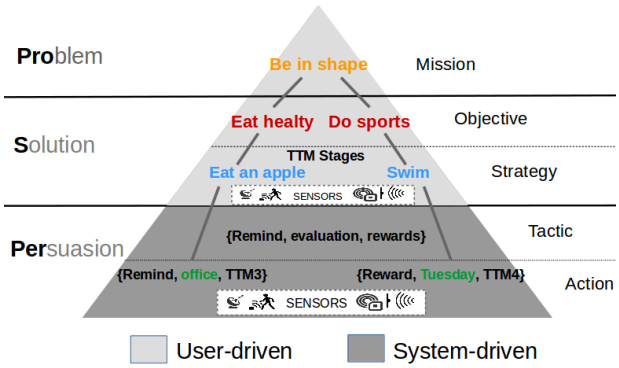

Figure 4. ProSPer Mode instantiated on a user targeted behavior

Problem layer : missions

The concept of Mission describes what the user wants to change without requiring the user to provide any solution for the problem. In the scenario we provided, a possible mission added by the user Bill could be "Being in shape"M_1. This mission name states the context of the problem without giving any additional characterization based on the user preferences (no qualitative nor quantitative characterization). It is important to observe that when a user adds a new mission he/her is already over the TTM (Trans Theoretical Model) stage of pre-contemplation, which means (according to the TTM model) contemplating the idea of targeting a specific behavior change considering pros and cons.

Solution layer : Objectives and Strategies

In this layer the user will define the solutions for the upper layer. In first place the objectives are inserted. An objective is a generic solution to complete the mission, in other words, it does not take into account the user preferences but it is just an abstract solution given by his/her knowledge.

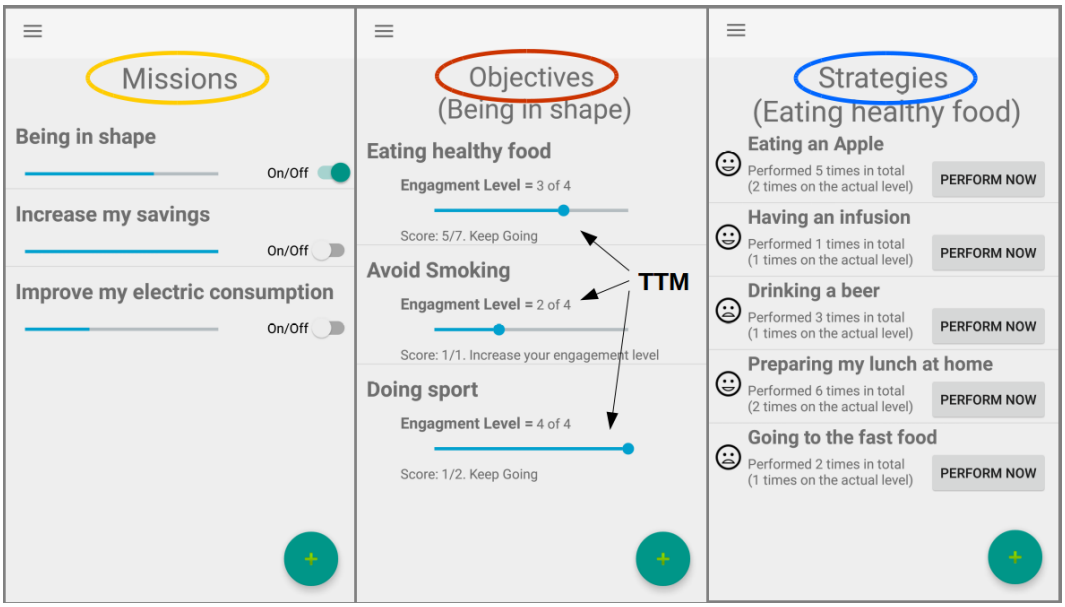

Figure 5. Missions(left), Objectives(center) and Strategies(right) layouts

The strategy instead can be interpreted as a concrete instantiation of the solution on user preferences and in the context of use provided by the sensors. In the example, the objective for the mission M_1 is "Eat healthy food"O_1. When an objective is specified, the user can personalize it with strategies pertaining to his/her profile. In the example for the objective O_1 a given user specifies "Eating apples"S_1 while another one could choose "Eating bananas"S_2. You can notice that eating apples or bananas are strategies compliant with the objective O_1 but other strategies that are not compliant with the objective O_1 can also be specified as in the example for "Going to fast food"S_3.

Persuasion layer : Tactics and Actions

In this layer, we care about how to persuade combining the strategies with the stage of change of the user (precontemplation TTM_0, contemplation TTM_1, preparation TTM_2, action TTM_3, maintenance TTM_4 and relapse TTM_5). Tactics are generic actions that describe how to deliver persuasion to the user. Tactics can be implemented using a light in an apartment, a message on the phone screen or an audio signal coming from the HI-FI installed in a car. Examples of tactics can be remindersT_1 to current target behaviors, suggestionT_2, evaluation/rewardsT_3, but also explanations provided to the user through messages. Tactics depend on the device on which the system is implemented. Tactics need to be combined with strategies to become operative through actions. We can define an action as follows

$$A = (S, \{T_1 ... T_n\}, TTM_x) \quad (1)$$

where A is the action, S the strategy, T_1 to T_n the set of matching tactics and TTM_x the stage of the change of TTM in which the user is.

Sensor layer

This layer gives the fundamental information that permits to apply persuasion in context in an operational way. We propose three examples using the time of the day and the GPS as sensors.

Let's consider user A with the following details :

- **Mission** : "Be in shape"
- **Objective** : "Eating healthy food"
- **TTM stage** : 3 (Action stage)
- **Strategy** : "Eating an apple"
- **Tactic** : "In the office" (Latitude X, Longitude Y)

Then we consider some entries present in the "action level" of user A as for example :

- $Action_1$: When user A is in the CONTEXT [8 :00 AM] a message will SUGGEST the list of possible strategies to be applied during the day (e.g. Eating an apple).
- $Action_2$: When user A is in the CONTEXT [Latitude X, Longitude Y] a notification will REMIND to eat an apple.
- $Action_3$: When user A is in the CONTEXT [10 :30 PM] a message will ask to EVALUATE the strategies done during the day (e.g. if he/she eats an apple in the office)

In the examples above we can see how persuasion is applied not only in a conceptual way but in an operational one, in fact if user A was in Maintenance stage (TTM = 4) for the objective "Eating healthy food", ACTION 2 would have been suppressed since the Maintenance stage supposes that the user does not need such a kind of notifications.

IMPLEMENTATION

The aforementioned ProSPer extension has been implemented in Java for Android following a Model-View-Control (MVC) architectural pattern where :

- **The model** represents the domain objects made persistent using an Ormlite database, describing the concepts of Mission, Objective, and Strategy.
- **The view** consists of layouts of a main Android activity invoking fragments to perform the Tactics. A recycle viewer is in charge of replacing a container

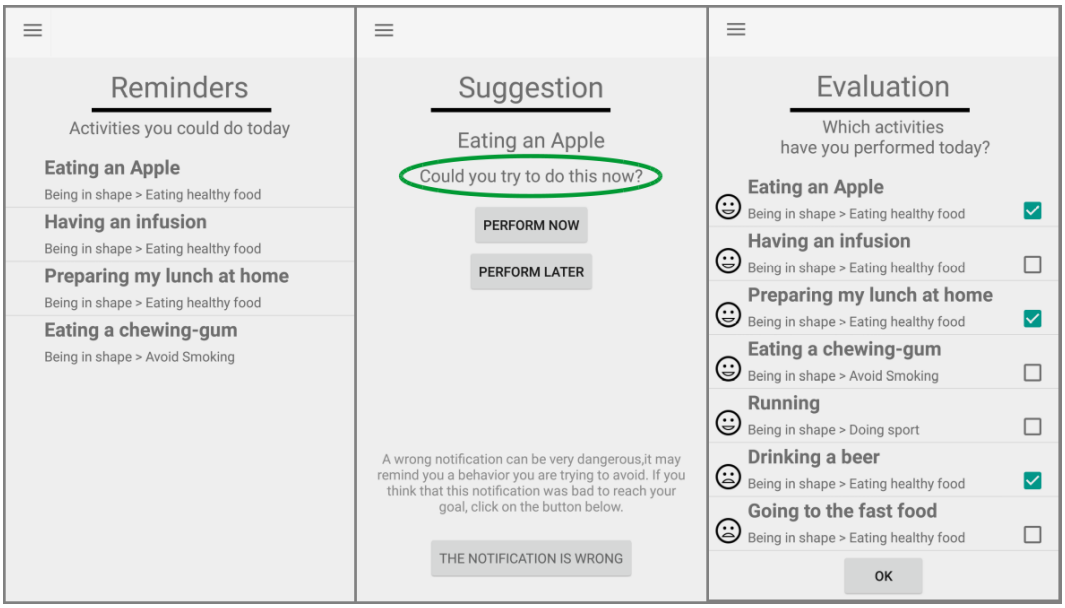

Figure 6. Remind(left), Suggest(center) and Reward/Evaluate(right) tactics

object with the actual frame to be displayed. The notifications are part of the view and they appear on the notification bar of the Android system.

— **The control** is represented by a persuasive controller thread managing the sensors and the Actions to be executed. The thread has a refresh cycle of 1 minute in order to check the current time/place and to query the database for possible strategies satisfying the applicability conditions of TTM stage.

In Figure 5 we show the layouts of the Android application in which users are able to add/remove Missions (Left) Objectives (Center) and Strategies (Right). In the Missions layout there is a switch to select the active Missions while a progress bar indicates the state of the user in achieving each of the missions. In the Objectives layout the seek bars represents the TTM stage of the user for each Objective. Finally in the Strategy layout the users are able to declare when they perform the behavior depicted by a sad/happy smiley as not-conform/conform to the Objective.

In Figure 6 three tactics are implemented to drive the persuasion : remind (Left), Suggest (Center) and (Evaluate). The users personalize at what time reminders and the evaluation will be shown during the day and at that time they are asked to consider what they could potentially do during the day (remind) and to self-evaluate if they actually perform the behavior at the end of the day (evaluate) increasing the statistics. The suggestions instead incorporate the concept of Strategy of ProSPer considering the context in which the Strategy can be applied.

PILOT STUDY

Goal

In order to assess the ability of users to apply the MOST4P model to their use-case and in order to evaluate the capability of the MOST4P extension ProSPer to drive persuasion to users, we set up a pilot study involving 12 subjects recruited in other departments of our organization through a mailing list of volunteers. A complete process of change can take long period for a person (months, years...), for this reason a significant evaluation of the behavior change is not accurate and is not the main objective of this study.

Hypothesis

The general focus was to evaluate the perceived usefulness of a persuasive system based on a MOST4P/PROSPER paradigm, investigating in particular on :

— H1 : MOST4P/PROSPER based approach is suitable to describe changes

— H2 : the PROSPER extension allows to drive a context-aware persuasion to the users.

Protocol

Twelve subjects (5 males and 7 females) participated in this experiment for one week. Before participating to the experiment, each candidate was first informally interviewed to check their motivations to introduce a significant change in their own life. The resulting 12 subjects were coming from 7 different countries belonging to the 5 different continents with different types of background and occupation (e.g., students in computer science, teachers and students in various languages, researchers in social and exact sciences, as well as clerical staff).They were aged between 22 and 53 ($\mu = 31.91, \sigma = 10.15$). The pilot study was divided in to three parts : the first, involving a pre-experiment questionnaire, the second involving the experimenting of the implementation of one model and third, a debriefing questionnaire based on the IBM CSUQ evaluation. This protocol has been already used for this kind of studies as for example in RightOnTime [13] in which 5 participants where asked to experience for 5 days a persuasive system to improve their punctuality.
The reader will found below the details of each one of the three stages of the pilot study

Pre-experiment Questionnaire

The purpose of this pre-experiment questionnaire was to identify how people define, structure, and approach any be-

havioral change. Participants were informed on the general purpose of the study and asked to answer to open questions regarding "What they wanted to change in their life as a behavior and attitude ? (Table 1), "How they approached to the change ?" (Table 3), "What kind of result they had and in case of failure what was the relapse cause ?" (Table 2).

In addition to the previous questions we also asked participants to give a possible structured approach to target their behavioral change asking finally to use the MOST4P model as framework. Participants where indeed asked to draw on paper the instantiation of their use-case according to the MOST4P model. In a first moment we asked to perform this instantiation without giving any definitions of what Mission Objective Strategy and Tactics stood for, some of them could guess it naturally, others needed the definitions while the remaining part needed more than two attempts and some guidance (Table 4).

Manual and digital experimentation of MOST4P

After the pre-experiment questionnaire we asked the participants to engage a 5 days experiment to be conducted on a targeted behavior provided in the questionnaire. Two of them decided not to take part to experiment since they did not accept that engagement but they agreed in answering to our pre-experiment questionnaires. For the remaining ten, we provided the aforementioned bracelet to 5 participants and the Android application to the remaining 5. We set up the corresponding target behavior for the participants using the color strings in the case of the bracelet and the digital environment provided by the application in the case of the Android implementation. We want to underline that a complete comparison between the bracelet and the Android application was not the objective of this work : from both we could evaluate the perceived usefulness in structure the targeted change, from the Android application instead we could investigate about a context-aware persuasion autonomously driven by the device and not left to the user as in the bracelet case.

Debriefing questionnaire

At the end of the 5 days of experimentation we sent an on-line questionnaire to participants to evaluate their experience applying and using the Model through the two different implementations. We relied on the IBM Computer Satisfaction Usability Questionnaire (CSUQ) [8], an empirically-validated 19-question questionnaire benefiting from an $\alpha = 0.89$ reliability coefficient related to usability, thus meaning that answers provided by participants to this questionnaire demonstrate a high correlation with the usability of the system being evaluated. Each IBM CSUQ closed question was measured using a 7-point Likert scale (1=strongly disagree, 2=largely disagree, 3=disagree, 4=neutral, 5=agree, 6=largely agree, 7=strongly agree) and was phrased positively as follows :

1. Q1 : Overall, I am satisfied with how easy it is to use this model.
2. Q2 : It was simple to apply this model.
3. Q3 : I can effectively complete my task applying this model.
4. Q4 : I am able to complete my task quickly applying this model.
5. Q5 : I am able to efficiently complete my task applying this model.
6. Q6 : I feel comfortable applying this model.
7. Q7 : It was easy to learn to applying this model.
8. Q8 : I believe I became productive quickly applying this model.
9. Q9 : The model provides me with structured guidance on how to fix problems.
10. Q10 : Whenever I make a mistake using the model, I recover easily and quickly.
11. Q11 : The information provided by the model and its accompanying method is clear.
12. Q12 : It is easy to find the information I needed.
13. Q13 : The information provided for the model is easy to understand.
14. Q14 : The information is effective in helping me complete the tasks and scenarios.
15. Q15 : The organization of information on the model screens is clear.
16. Q16 : The interface of this model is pleasant.
17. Q17 : I like using the interface of this model.
18. Q18 : This model has all the functions and capabilities I expect it to have.
19. Q19 : I am satisfied in using this model.

After the 19 predefined questions we added six specific questions : inspired by the IBM Post-Study System Usability Questionnaire (PSSUQ), six closed questions were added to focus on specific aspects of the system being evaluated after the study has been conducted and measured according to the same 7-point Likert scale as follows :

1. Q20. I was able to remember my Missions-Objectives-Strategies-Tactics.
2. Q21. Using the model increased my motivation in changing (corresponding to Fogg's motivation)
3. Q22. Using the model increased my ability in changing (corresponding to Fogg's ability)
4. Q23. Using the model simplified my change (corresponding to Fogg's simplicity)
5. Q24. Using the model triggered me to act (corresponding to Fogg's trigger)
6. Q25. I would recommend people using the model in the future

In addition to the Likert scale items we inserted also an after-scenario questionnaire consisting in an open question phased as "List the most negative aspect(s) :","List the most positive aspect(s) :" and "Provide some optional general comments on your experience". Then, for each participant, the questionnaire was added into a database, along with the results of the experiment and other data. The data was entered in an anonymous format so the participants could not be identified. The data were analyzed by a dedicated MS Excel sheet combining graphs and inferential statistics.

RESULTS

Pre-Experiment

From the pre-experiment questionnaires we were able to picture that along with a predominant percentage of participants that intended to improve their shape, most of the answers were related to management/planing issues. We found interesting that the desired improvement on management/planning is strictly related to the major cause of relapse of the on-going change. The "Dense everyday schedule" figures as a real issues for people that attempt to change their behavior. As leading examples provided by participants we found "Stress due to work" and "Incompatibility with the family needs" which do not permit a regular focusing on the change. What is mentioned in the statistics as "Lack of motivation" instead is often related to procrastination by the user and to previous unsuccessful attempts in change that decrease significantly the participants' motivation in engaging the change. In a small percentage instead participants did know how to maintain the change and so they experienced a lack of ability in the change itself.

Targeted change	Percentage
Be in shape	25%
Improve Time management	20%
Better management of entertainment	15%
Sleep better/more	10%
Save Money	10%
Better organize my items	10%
Wake up earlier	5%
Be more organized	5%

Table 1. Changes targeted by participants

Cause	Percentage
Dense everyday schedule	53.85%
Lack of Motivation	38.46%
Lack of Ability	7.69%

Table 2. Major cause of relapse of an on-going change

We asked participants to illustrate the instruments, and tools they used to engage, follow or maintain the change. Most of them did not use any instrument, only willpower. The remaining part was using a traditional approach as keeping updated a physical or digital TO-DO list or just using traditional instrument as noting on the calendar or setting up alarms in their smart-phones. A small percentage tried to use persuasive technology in form of Android applications in particular related to health (e.g., Doing sports regularly, Quit smoking).

Instrument	Percentage
Willpower	41.67%
Tool or General Technology	41.67%
Persuasive Technology	16.67%

Table 3. Instruments used in the past by participants to change

When we ask participants to apply the MOST4P model to their use-case we found that everybody was picturing a structured answer, in general made of steps. Most of them did not have problems applying directly the model according to their own interpretation of Mission Objective Strategy and Tactics while the rest needed either just the definition or more help to complete the task, proposing different words or order for Mission Objective Strategy and Tactics.

#Iterations	Percentage
At first attempt	50.00%
At second attempt (with definitions)	33.33%
More than two attempts (with guidance)	16.67%

Table 4. Number of iterations while applying MOST4P

Questionnaire results

Figure 7 graphically depicts the distribution of the answers provided by the participants on the 19 IBM CSUQ questions. Each cumulated horizontal histogram of Figure 7 could be interpreted as follows : a score between 6 and 7, represented with dark green, is considered as excellent ; a score of 5, represented with light green, is considered as good ; a score of 4, represented with yellow, is considered as average ; a score of 3, represented in orange, is considered as poor ; and a score between 1 and 2, represented in red, is considered very bad. In general, a score between 'average' and 'excellent' should not raise any particular concern regarding this question, whereas a score between 'poor' and 'very bad' should raise some discussion in order to investigate why this question has been depreciated so much. Figures 8 and 9 and summarise the aggregated CSUQ sub-metrics reported in table 5. Each CSUQ questionnaire involves the calculation of four quality metrics of the system being evaluated as follows :

1. System usefulness (SysUse : Items 1-8)
2. Quality of the information (InfoQual : Items 9-15)
3. Quality of the interaction (InterQual : Items 16-18)
4. Overall quality of the system (Overall : Item 19)

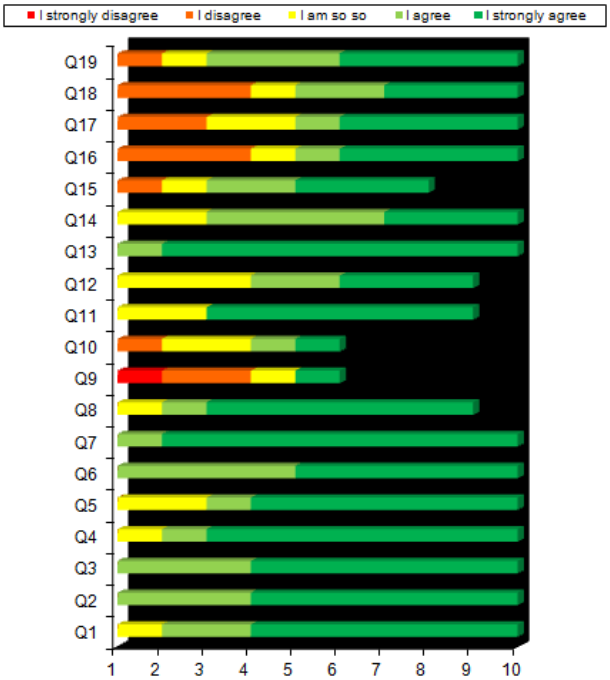

Figure 7. Distribution of participants' answers to the IBM CSUQ questionnaire.

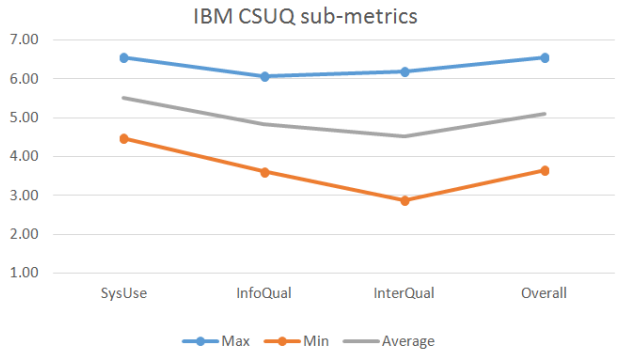

Figure 8. Aggregated scores by CSUQ sub-metrics (Min, Max, Average)

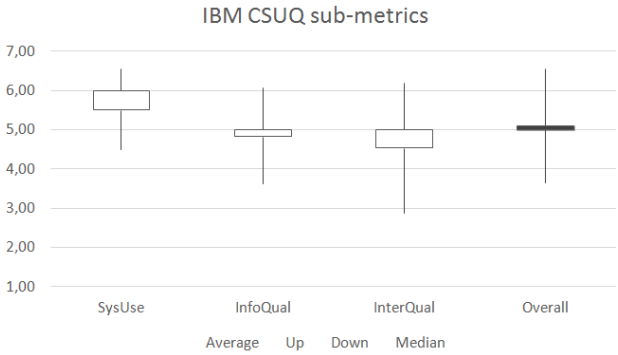

Figure 9. Aggregated scores by CSUQ sub-metrics(Average, Up, Down, Median)

Figure 7 suggests that the global subjective satisfaction of participants involved in the experiment follows a rather positive trend since Q19 is interpreted positively by only 8 users out of 10 (Q19, $\mu = 5.10, M = 5, \sigma = 1.45$), but with some deviation though. The most positively evaluated sub-metric is certainly the system usefulness (Q1-Q8, $\mu = 5.52, M = 6, \sigma = 1.04$) : all eight questions do not have any negative answers, the average is the highest and the standard deviation is the smallest, thus suggesting that respondents tend to agree that the whole system is very useful to them. Second comes the information quality (Q9-Q15, $\mu = 4.84, M = 5, \sigma = 1.05$) : the average is still considered high as well as the median with small deviation. However, question 9 (Q9 : $\mu = 3.33, M = 3, \sigma = 1.51$) raises a particular concern : it is the only question receiving strong disagreement, thus indicating that the MOST4P model is probably structuring, but that the system does not provide end users with enough information on how to fix a problem when any. Question 9 is the most negatively assessed question. The system is evaluated positively regarding the information in general, except for guidance. Next comes the interaction quality (Q16-Q18, $\mu = 4.53, M = 5, \sigma = 1.66$) : all questions have some negative answers, the average is lower with a more disperse variance, thus indicating that there is no strong agreement among the respondents regarding to this sub-metric. In particular, "Q1. Overall, I am satisfied with how easy it is to use this system" ($\mu = 5.40, M = 6, \sigma = 1.17$) suggests that the general attitude of participants regarding the whole process supported by MOST4P could be interpreted as satisfying with respect to the main goal. Question 7 (Q7 : $\mu = 6.20, M = 6.5, \sigma = 1.03$) is the most positively assessed question, thus suggesting that easiness is the most preferred quality property of the system being evaluated, which is encouraging. The analysis of the CSUQ sub-metrics in Table 5 and Figures 8 and 9 evidences that participants perceived as "useful" the model ($\mu = 5.52, M = 6, \sigma = 1.04$) and said to be "Overall satisfied" ($\mu = 5.10, M = 5, \sigma = 1.45$). We remark that despite the sufficient average of measurements, further experiments are necessary to evaluate the quality of information and of interaction sub-metrics affected by the first early prototyping of the Android application interface and also by the inapplicability of some questionnaire items to the bracelet case. Figure 10 reports on the last questions of the questionnaire : the remembrance seems to be positively appreciated ($\mu = 5.40, M = 5.0, \sigma = 1.17$), as well as the level of support in the 4 Fogg's activities ($\mu = 4.85, M = 5, \sigma = 1.35$ for the cumulated figures for all 4 questions). Participants were mixed up regarding their recommendation to others to use the system ($\mu = 5.00, M = 6.00, \sigma = 2.00$) : not only they are not sure whether they would recommend using the system to other people, probably because the effective usefulness highly depends on the user's capabilities and motivations, and the variation is the largest observed for all questions ($\sigma = 2.00$), which indicated that their opinions have a significant discordance. This should not be confused with the perceived usefulness, for which a large consensus was obtained.

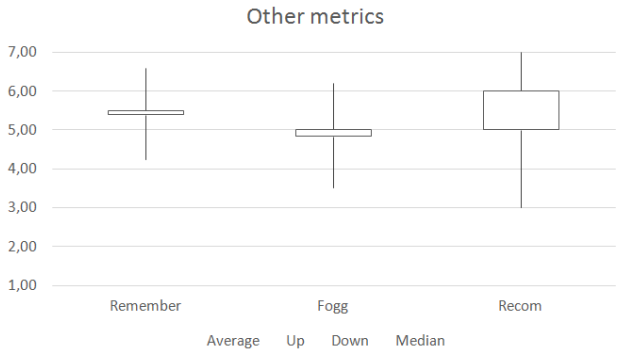

Figure 10. Other scores from the questionnaire

sub-metric	Mean	Median	Avg. dev.	Std. dev.
SysUse	5.52	6.00	0.84	1.04
InfoQual	4.84	5.00	1.05	1.23
InterQual	4.53	5.00	1.47	1.66
Overall	5.10	5.00	1.12	1.45
Total	5.11	6.00	1.08	1.29

Table 5. Aggregated scores by CSUQ sub-metrics

CONCLUSION

In this work we focused on how to structure the multi-domain changes for the users (refined thanks to the MOST4P paradigm) and on how to integrate the knowledge in the persuasive field to drive an effective persuasion (integrating those techniques in the ProSPer extension involving the context).

From the overall pilot study, the results suggest that there is indeed a perceived usefulness by participants in using

a MOST4P-compliant persuasive interactive system, but that there are several conditions to be fulfilled to reach an effective usefulness. Fogg [5] reports that a persuasive system becomes effectively and efficiently useful as soon as two conditions are satisfied : capabilities and motivations should reach together a certain threshold to trigger the action that will ultimately result on effective results. Our study refines the Fogg principle by observing that the context of use significantly influences the effective usefulness. A participant could exhibit enough capabilities and motivations (which we combine into a parameter called user overall predisposition), but the context in which the persuasion is applied may induce a different risk depending on the conditions provided by this context.

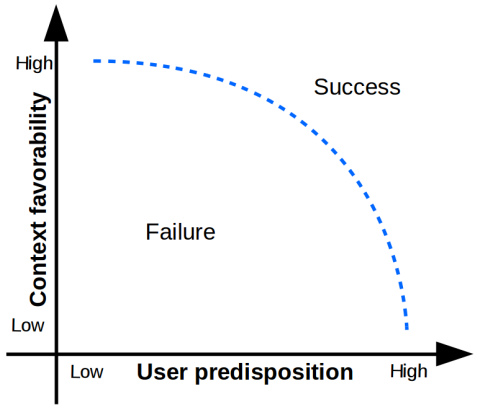

Figure 11. Success/Failure threshold related to Context Favorability and User predisposition

Figure 11 graphically depicts this suggestion : on the *X*-axis the predisposition of the user to change (theoretically motivated and able to change independently from the context), and the context favorability (where the user is practically capable of change according to the context) represented on the *Y*-axis. Similarly to the Fogg Behavior Model, the dashed blue curve acts as a threshold dividing the zone of the plane in which the behavior change is likely to happen(upper-right part) from the zone in which it is likely to fails (lower-left part).

Discussion and Perspectives

Even if our study lasted for a shorter time, a long term experimentation could be possible on ProSPer since the implementation provides in the objective the possibility of choosing an the "engagement level". This variable is connected to the stages of the Transtheoretical Model of Behavior change and so it could be possible to evaluate "the evolution" over a long period of a change looking at the time it takes to users to pass trough the levels.
In the perspectives of this work we are going to explore the zones involving the failure and the success in order to address a personalized instantiation of the curve in Figure 11 on a specific context/user. From this viewpoint, we expect that each axis is graduated into three steps : low, medium, and high. In principle, the user should reach a certain threshold to trigger effective usefulness. Therefore, the top right quadrant, which is graphically depicted in light green in Figure 11, represents the ideal situation : the end user has enough disposition and the context is supportive (e.g., it is impossible to stop smoking in the middle of other smokers). If the users' predisposition or the context feasibility are below their respective thresholds, the risk of a successful persuasion remains medium, but not ideal. For instance, to stop smoking while remaining in the same working (probably stressful) conditions will invite the person to repeat the used gestures instead of avoiding them, but it is still doable if the person has enough motivations or the context becomes more supportive (people around encourage the candidate). When the user disposition is still higher than

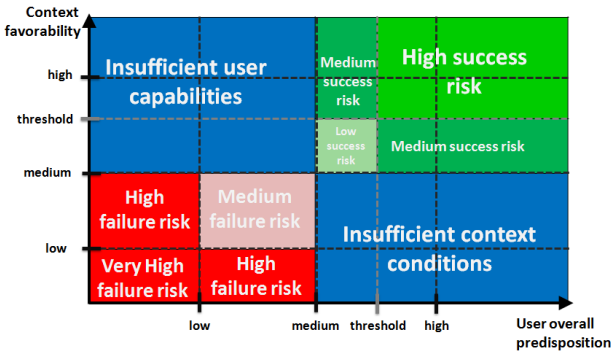

Figure 12. A possible more accurate version of the zones of Success/Failure related to Context Favorability and User predisposition

medium, but the context is not supportive enough (bottom right quadrant depicted in blue), the context does not meet sufficient conditions to support the candidate. Similarly, when the context feasibility is still higher than medium, but the user has not enough predisposition (top left quadrant in blue), the candidate exhibit insufficient capabilities to reach the goal. When the user predisposition and/or the context feasibility go below medium capabilities, the failure risk becomes high to very high, as depicted in red in the bottom left quadrant of Figure 12. Yet, it could happen that a very highly motivated candidate could still reach goal, even if the context is not supportive enough and that a very highly supportive context may help a moderately motivated person, but these are exceptions.

We therefore suggest that this expands Fogg's model by taking into account the context in which the persuasion takes place : if the context is not supportive enough, the end user predisposition could be high, but not high enough to reach the persuasion. It is very hard to stop eating chocolates if the surrounding people do not do the same, as well as it is very hard to stop smoking in normal conditions. Therefore, it becomes important to leave the actual context of use and to migrate to another one in order to be in the right contextual conditions to trigger an effective success. Hence, it becomes crucial to identify which contextual parameters (*contextual determinants*), could leverage or not the context feasibility so as to act on them. The MOST4P model and its ProSPer extension enable to do that.

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