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Editorial Preface

Issue 5.3 of Psychnology Journal and some other issues in 2008 will include selected works presented at CHItaly07 (http://www.chitaly.org), the Fifth Symposium on Human-Computer Interaction sponsored by the Italian Chapter of ACM Special Interest Group on Human-Computer Interaction. The spirit of the symposium was to offer a place where HCI researchers could meet and present their work to other colleagues from Italy and abroad; in doing so, the attendants could also take advantage of two parallel events focused on ergonomics and e-Health respectively, and of the presence of three keynote speakers illustrating as different issues as design and interactivity (David Kirsh from UCSD), collaboration technology (Steven Poltrock from Boeing) and Cybertherapy (Brenda Wiederhold from Interactive Media Institute, San Diego and Brussels).

PsychNology Journal always tries to represent the rich heterogeneity of issues that gravitate around the human relation with technologies, without disciplinary or thematic limits. CHItaly07 contributions, transformed into peer reviewed articles for PNJ, reflect this heterogeneity. In this issue we will include a work on assistive robots for elderly users in domestic environments (by Amedeo Cesta, Gabriella Cortellessa, M. Vittoria Giuliani ,Federico Pecora, Massimiliano Scopelliti and Lorenza Tiberio); a museum application of an interactive multimedia tool (Davide Bolchini, Nicoletta Di Blas, Franca Garzotto, Paolo Paolini and Aldo Torrebruno); a teachers-to-be discussion group (Valentina Grion and Bianca Maria Varisco); and a risk management solutions identified by Fabiana Vernero and Roberto Montanari.

In addition to the papers by CHItaly07, readers will find in the 'Other Contents' section an insightful analysis of the possible similarities between Free Software and gift-exchange societies, by Andres Baravalle and Sarah Chambers.

With this issue we would also like to welcome four new editors who will help us covering more aspects of the large field we are targeting as a Journal. They are Ramakoti Sadananda from Rangsit University in Bangkok (Thailand), Paul F.M.J. Verschure from Universitat Pompeu Fabra in Barcelona (Spain), Albert "Skip" Rizzo from the University of Southern California, Los Angeles (USA) and Giulio Jacucci from the Helsinki Institute for Information Technology (Finland).

Finally, we are proud to announce that PNJ contents will be indexed by EBSCO; this agreement will give our authors an additional opportunity to increase the visibility of their work in the scientific community.

The Editors-in-Chief

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Psychological Implications of Domestic Assistive Technology for the Elderly

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ABSTRACT

The ROBOCARE Domestic Environment (RDE) is the result of a three-year project aimed at developing cognitive support technology for elderly people. Specifically, the domestic environment is equipped with sensors, intelligent software components and devices which cooperate to provide cognitive support to the assisted person. The ROBOCARE interaction capabilities have been concentrated in a robotic mediator who acts as the main communication channel between the users and the intelligent domestic environment. This paper presents an evaluation of elderly people's perception of assistive robots and smart domotic environments. Results show how the acceptability of robotic devices in home setting does not depend only on the practical benefits they can provide, but also on complex relationships between the cognitive, affective and emotional components of people's images of robot. Specially, we analyzes a number of evaluation criteria related to the robot's aspect, the way in which it communicates with the user, and the perceived usefulness of its support services. Among these criteria, the paper proposes and reports an evaluation of how perceived frailty, with reference to both health in general and fear of cognitive weakening, more specifically, can influence the evaluation of a potential aid in everyday life, namely the robotic assistant. The paper also provides a discussion which can be useful for the design of future assistive agents and socially interactive robotic.

Keywords: *socially assistive robots, intelligent sensorised environments, evaluation of human-robot interactions, acceptability, perceived health.*

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1. Introduction

The use of intelligent technology for supporting elderly people at home has been addressed in various research projects in the last years (Pineau, Montemerlo, Pollack, Roy, & Thrun, 2003; Pollack, 2005). In addition, recent research has been increasingly focusing on Cognitive Systems to produce aids that enhance human cognition capabilities (Myers, 2006). The state-of-the-art in robotics allows now an increasing emphasis on human-robot interaction in general and on social assistive robotics in particular. The emphasis in the latter is to support human users through social rather than physical interaction (Feil-Seifer & Mataric', 2005). A key aspect of social assistive robots consists in social interaction between human users and robotic agents. For example, Sabanovic, Michalowski and Simmons (2006) highlighted how observation and behavioural analysis of human-robot social interaction in real environments is necessary in order to take into consideration all the divergent factors pertaining to the design of social robots. The design of social robots also raises a number of ethical issues that need to be discussed within the research community to provide guidance to system designers. Turkle, Taggart, Kidd and Daste (2006) considered some of the ethical implication of human-robot interaction, mainly related to the kind of authenticity we require to our technology as well as to the choice of the most appropriate relationship between children/elders and relational artefacts.

The ROBOCARE project is in line with several of the mentioned projects and examines some of the relevant factors for the design of assistive robots. The project has involved research groups with different backgrounds with the goal of investigating how state of the art AI (Artificial Intelligence) and robotics techniques can be combined to create new domestic services for elderly people (Cesta & Pecora, 2006). The project has produced a prototype of integrated home environment, called RDE (ROBOCARE Domestic Environment), composed of a robotic interactive agent, some sensors for continuous monitoring, and additional intelligent systems that store and reason upon knowledge about the assisted elder's scheduled activities. A multi-agent coordination algorithm guarantees the coherence of the behaviour of the whole environment. This provides a functional cohesive which invokes the smart home's services so as to preserve safeness of the person and provide suggestions. How the different interactive functionalities are obtained is described in Cesta, Cortellessa, Pecora and Rasconi (2007).

The RDE includes a mobile robotic platform with interaction capabilities. This robot provides an interface between the RDE and the user: indeed, the entire smart home is accessible to the user in the form of an assistive robotic companion. In the spirit described in (Feil-Seifer & Mataric', 2005) the RDE is an example of Social Assistive Robot, a concept which can be distinguished from Social Interactive Robot (Fong, Nourbakhsh, & Dautenhahn, 2003) because its main task is to monitor and assist the elder user rather than simply interacting with him/her. Since its beginning, ROBOCARE has raised numerous challenges. In particular one, also reported in Tapus, Mataric' and Scassellati (2007) has been paramount in our work: "what are the circumstances in which people accept an assistive robot in their environment?". Other important questions we have strived to answer (or at least investigated) are ``how should an elder user communicate with a robot?", "should the robot look like a human being?", and, last but not least, "are robots useful in the domestic environment?". This paper comes after three years of development in which we have attempted to realize a prototypical domestic environment equipped with an assistive robot. The aim of the paper is to describe an *a-posteriori* evaluation of the intelligent environment. In particular, we present experiments aimed at understanding the perception of older people towards the assistance that this robot is able to offer at the moment. Specifically, the analysis of psychological implications in the interaction between the user and the intelligent environment; in other words, how the robotic mediator is perceived by the elder user.

2. The ROBOCARE Assistive Domain

The ROBOCARE Domestic Environment is aimed at demonstrating instances in which the coordinated operation of multiple household agents can provide complex support services for the elder user. For instance, suppose the assisted person is in an abnormal posture-location state (e.g., lying down in the kitchen). The intelligent home should recognize this situation and react to the contingency by dispatching the robot to the person's location. The robot should then ask if all is well, and if necessary sound an alarm. A meaningful example: the smart environment detects that the time bounds within which to take a medication are jeopardized by an unusual activity pattern (e.g., the assisted person starts to have lunch very late in the afternoon); as a consequence, the system should verbally alert the assisted person of the possible future

inconsistency. An even more advanced form of reasoning-driven interaction could be the following: the assisted person asks the intelligent environment (e.g., verbally) whether he/she should take a walk now or wait till after dinner; the request is forwarded to a specialized reasoner which propagates the two scenarios (walk now or walk after dinner) in its temporal representation of the daily schedule, and the result of this deduction is relayed to the assisted in the form of verbal advice (e.g., ``if you take a walk now, you will not be able to start dinner before 10:00 pm, and this is in contrast with a medication constraint''). The objective of our prototype is to show how a collection of service-providing and very diverse agents (namely, in our specific case, artificial reasoners, robots and smart sensors) can be integrated into one functionally coherent system which provides more added value than the sum of its parts (see Figure 1). The type of elementary services deployed in the RDE mirrors the domotic components that will be available on the market in the near future. In this context, a special focus of ROBOCARE has been to explore the role of an embodied agent which provides an interface between the assisted person and his or her smart home environment. Our integration effort has yielded an integrated environment that interacts with the assisted person through what we have called a *robotic mediator* (see Figure 1). The base on top of which the robotic mediator is built consists in a Pioneer platform. The mobile platform is equipped with additional sensors, namely a laser range finder, a stereo camera and an omni-directional camera, as well as additional computational resources consisting in two laptops, one for on-board sensor processing and navigation and one for human-robot interaction. The robot is endowed with verbal user□interaction skills: speech recognition is achieved with the Sonic speech recognition system (University of Colorado)[1], while speech synthesis is driven by a simple text-to-speech system.

The objective of the RDE is to provide on-demand as well as proactive support in the management of an elderly person's daily activities. To this end, the RDE is composed of two fundamental subsystems. On one hand, an "intelligent observer" of the assisted person: information coming from environmental sensors is used for maintaining an updated representation of what is happening in the environment. The sequence of observations from the artificial vision sensors allows following the evolution of the activities of the observed person. Based on the synthesis of these observations, the system is able to generate a report that underscores when the person's activities have been performed within "reasonable" temporal boundaries or when important anomalies

[1] For details, see \url{cslr.colorado.edu/beginweb/speech_recognition/sonic.html

or even violations on their execution have been detected. In this light, the RDE's basic functionality is an example of home Activity Monitor grounded on scheduling technology. Notice that, on its own, the domestic activity monitor acts as a "silent observer" and does not take initiative with respect to the elder person in any way.

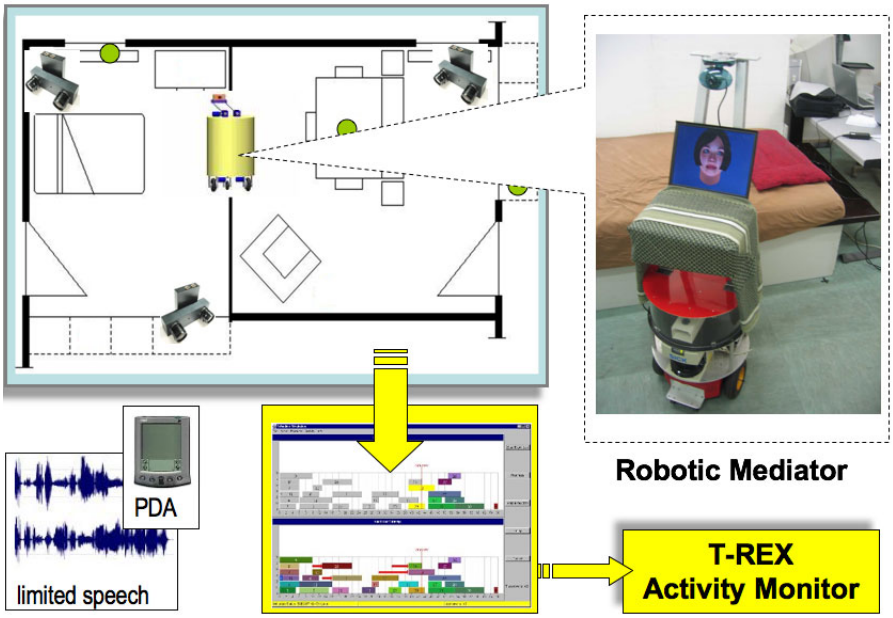

Figure 1. The ROBOCARE heterogeneous ingredients

On the other hand, the RDE also provides an interface with the assisted elder through an interactive subsystem. This subsystem is essentially a "proactive assistant" which closes the loop between the elder user and the intelligent environment, enabling the system to take initiatives based on Activity Monitor inference.

As a central component for the activity management we have employed an AI-based schedule management environment called T-REX – Tool for schedule Representation and Execution (Pecora, Rasconi, Cortellessa, & Cesta, 2006). T-REX allows representing a set of activities and their quantitative temporal connections (i.e., a schedule of activities that the user is expected to carry out). These temporal constraints represent the behavioural requirements to which the assisted person should adhere.

An "ideal schedule" is an enactment of these activities which does not violate any temporal constraint. Broadly speaking, the objective of the Activity Monitor is to recognize deviations from the ideal situation. Specifically, the system should assess the extent to which the elder user's behaviour deviates from this situation. This

equates to assessing which temporal constraints are progressively violated during the day. In a nutshell, system interventions are driven by constraint violations: warnings, alarms and suggestions result from violated constraints, which are processed by the interactive subsystem on board the robotic mediator.

2.1. Managing Interaction with the User

As already mentioned, interaction within ROBOCARE relies on an embodied robotic assistant as the focal point between the user and the system. Communication between the user and the robotic mediator occurs verbally. We implemented two forms of interaction based on who takes the initiative to start a dialogue:

On-Demand interaction in which the user takes the initiative first. The assisted person commences interaction, for instance, by querying the system's knowledge base: "have I taken my pills?", or "can I make an appointment for tomorrow at 5 PM?".

Proactive interaction in which the intelligent environment commences interaction guided by its internal reasoning. Within ROBOCARE, constraint violations have been considered as a trigger for the system to take the initiative and perform some actions: issue an alarm in case of illness, or verbalize warnings and suggestions.

We categorize as On-Demand interaction the "Question/Answer" category of dialogues. This activity is triggered by a speech input from the assisted person. The generation of the answer is managed mostly internally to the manager that has information on the activities' history and/or on the current state of the environment, to answer questions like. "Have I had lunch?" or "What time is it?", etc. Instances of Proactive interaction are "Danger" and "Warning" scenarios. Undoubtedly, one of the important tasks for assistance is to recognize emergencies for the monitored person. The emergency trigger is fired by particular combinations of the input provided by the sensors that monitor the environment and the assisted person. As an example we can discriminate as a dangerous situation the case in which a person is "laying down on the kitchen floor" or "laying down in bed half and hour after usual wake up", rather than "laying down in bed within an expected period" which is recognized as a regular situation. The danger trigger is dealt with by a specific behaviour of the multi-agent system that interrupts the usual flow of activities and undertakes an action: the robot is sent to the assisted person, a specific dialogue is attempted, and if no answer from the assisted person is obtained, an Alarm is immediately fired to the external world (call to a relative, to an emergency help desk, etc.).

A warning scenario is one in which constraint violations are detected by the T-REX activity monitor. Broadly speaking, the activity monitor decides the values for the variables that are used by the interaction manager to trigger a proactive dialogue with the assisted person. The content of the dialog is synthesized on the basis of the monitor's internal knowledge.

3. Acceptability Requirements of Domestic Robots: Empirical Evidences

The issue of acceptability of technology and domestic robots by elderly people was addressed in literature in different studies.

Scopelliti, Giuliani and Fornara (2005) analysed preferences and basic requirements of domestic robots from the point of view of final users. This evaluation specifically addressed a variety of topics: the users' expectations with respect to the robot's capabilities to perform different everyday activities at home; their emotional response to a domestic robot; the image of the robot, referring to shape, size, colour, cover material, speed; preferences and expectancies about the robot's personification (given name, etc.) and the modalities of human-robot communication and interaction. Results showed that people underestimate cognitive capabilities and overestimate manipulative abilities of the robot, probably because such a device is still too far away from everyday life experience of laypeople, and their representations may be biased by science fiction. In addition, people at different stages of their lifespan showed very divergent opinions and preferences. In particular, elderly people clearly indicated a preference for a small robot, hardly resembling a human being, which has to intrude as less as possible in personal and domestic life; a device which is not autonomously free to move in the domestic environment and simply responding to tasks to be performed. Its practical utility was clearly recognized, yet the robot emerged as a potential source of worry at home, and the idea of a non-autonomous device seemed to be useful to reduce apprehension.

Another issue to be considered has to do with the context in which the device is expected to operate. The use of new technologies and domestic robots in the home environment is not only a matter of general human-technology interaction, but depends on the specific activity domain in which assistance is needed. In addition, the deep involvement of people with the home place (Giuliani, 1991; Rowles & Chaudhury, 2005) rises the question of possible reactions to modifications in the domestic

environment. In this respect Giuliani, Scopelliti and Fornara (2005) clearly outlined different levels of perceived utility and acceptability of a technological aid supporting the elderly in performing everyday activities. Elderly people showed a rather positive attitude towards a technological modification in the domestic environment, yet the inclination to use technological devices is strongly associated to the problem they have to cope with. In some situations, a technological aid seemed to be unrealistic, or unpractical, or it would have better been replaced by a more common alternative. Conversely, when health and personal/environmental safeness are implied, it emerged as a suitable solution to cope with losses imposed by ageing. Furthermore, Cesta Cortellessa, Pecora, & Rasconi (2007) highlighted in an experimental study a different evaluation of a domestic robot performing On-demand vs. Proactive activities in the home environment.

On the whole, the acceptability of a specific support is probably influenced by the coping strategies (Brandtstadter & Renner, 1990; Slangen-de Kort, Midden, & van Wagenberg, 1998) elderly people commonly utilize to manage the weakening of their competences, ranging from assimilative - involving an active modification of the environment in order to reach personal goals - to accomodative - involving a more passive acceptance of life circumstances and obstacles, and a personal adaptation to the environment. The choice among different strategies, far from being a matter of individual preference, is deeply influenced by how people perceive themselves and their personal control on the environment; in other words, it is a matter of perceived self-efficacy (Bandura, 1977). With increasing age and the weakening of personal resources, elderly people are more likely to experience a condition of psychological frailty (Rockwood, 2005; Strandberg & Pitkälä, 2007), that showed to be associated with a variety of behavioural modifications. For example, frailty caused by fear of falling is associated with an increase in social isolation (Rockwood et al., 2004) and an avoidance of activities (Delbaere, Crombez, Vanderstraeten, Willems, & Cambier, 2004; Li, Fisher, Harmer, McAuley, & Wilson, 2003; Zijlstra, van Haastregt, van Eijk, van Rossum, Stalenhoef, & Kempen, 2007). From our perspective, it is important to address the issue of how perceived frailty, with reference to both health in general and fear of cognitive weakening, more specifically, can influence the evaluation of a potential aid in everyday life, namely the robotic assistant.

3.1. Experiments with Elder Users

Apart from the research by Cesta, Cortellessa, Pecora, & Rasconi (2007), the studies on users' evaluations on domestic robots previously mentioned were mainly focussed on attitudes toward a purely imaginary assistive device, with unspecified abilities and not operating in a real domestic environment. For this reason, differences in users' reactions might have been related to both diverse knowledge and bias toward technologies.

The final prototype achieved by the ROBOCARE project allows us to overcome this limitation. In this article, we specifically aimed at understanding the psychological implications of older people-RDE interaction in a real environment, thus focusing on the evaluation of the assistance that the robot (and thus the assistive environment as a whole) is able to offer at the moment.

Figure 2a. Robot showing a human speaking face

Figure 2b. Non anthropomorphic version of the robot

Figure 2. The two experimental conditions of the robot.

Through the evaluation of the RDE prototype it is possible to draw specific conclusions on the prototype itself, and also to investigate some general issues relative to the challenges of assistive technology for elderly people. The approach we adopted is in line with recent recommendations for the evaluation of complex assistive technology. For instance, Hutchins (1995) recognized that human-robot interaction is

to be evaluated on socio-culturally constituted activities outside the design laboratory. In this light, the aim of our research is to analyze the potential reactions of final users to real life interactions between elderly people and an assistive robot.

In this exploratory study eight different scenarios were considered, which were meant to be representative of daily situations in which elderly people may be involved. The situations were selected with reference to previous research on this topic (Giuliani, Scopelliti, & Fornara, 2005), ranging from the most emotionally involving to less critical and emotionally neutral, with the aim of exploring elderly people's evaluations of the potential role of a domestic robot as a useful support in everyday life. Scenarios were arranged in order to cover a wide range of interactive situations: we specifically included both "On-demand" and "Proactive" scenarios (Cesta, Cortellessa, Pecora, & Rasconi, 2007).

On the whole, the present study focused on psychological reactions of potential elderly users to the RDE with reference to two main aspects.

First, we aimed at investigating users' preferences with respect to the robotic agent's resemblance to human beings. Even though in our RDE the robotic agent is not properly humanlike, we explored potential reactions of final users to two different versions of the same agent, in which this variable was manipulated (see Figure 2). Given its key role in elderly people's attitudes and preferences towards a domestic robot (Scopelliti, Giuliani, & Fornara, 2005) we proposed a version in which the robot has a 3D facial representation (whose lip movement is synchronized with the speech synthesizer), and one without a facial representation.

Second, we addressed the issue of elderly people attitudes towards the robot's features, interaction modalities and general suitability in the domestic environment (e.g., size, mobility, integration with the home), with particular emphasis on the potential influence of psychological characteristics of respondents on evaluations. Specifically, our aim was to explore the role of perceived frailty of the elderly on the acceptability of the robotic in the domestic environment. Are different levels in perceived health and worry about future cognitive losses predictive of a change in the evaluation of the robot's features and utility? If so, what is the direction assumed by this relationship?

3.2. Materials

Eight short movies (ranging from about 30 seconds to little more than one minute) were developed. The movies show potential interactions occurring in a real domestic

environment between an elderly person and the RDE's robotic agent. An experimental manipulation of the features of the robotic agent was employed, according to two different conditions: in the first condition ("Face") the movies show a robot having a human speaking face on a notebook monitor; in the second ("No-face"), we used a robot with no kind of human features (see Figure 3). In the eight scenarios we presented common everyday life situations in which the robot provides cognitive support to the elderly person. Scenarios referred to critical areas, as highlighted by Giuliani, Scopelliti and Fornara (2005): (a) management of personal/environmental safety, (b) healthcare, (c) reminding events/deadlines, (d) support to activity planning, (e) suggestions. In the following, the eight scenarios are shortly described[2]:

1. *Environmental safety*. The robot warns the assisted person of a potentially dangerous situation within the domestic environment.
2. *Personal safety*. This scenario depicts a medical emergency for the assisted person. The system detects the dangerous situation and issues an alarm to the assisted person's family.
3. *Finding objects*. This is an example of *on-demand* interaction where the assisted person relies on the robot's help to find objects within the environment.
4. *Reminding analyses*. In this scenario the robotic assistant reminds the user of a medical appointment he had forgotten.
5. *Activity planning*. In this scenario, the system supports the activity planning of the assisted person.
6. *Reminding medication*. This scenario describes an *on-demand* interaction in which the assisted person does not remember whether or not he/she took his/her medicine after lunch, and asks the robot.
7. *Suggestions*. This scenario depicts an example of system's initiative in making suggestions to the user regarding non-critical situations.
8. *Reminding events*. This is an example of cognitive support provided by the system in case of events not related to the assisted person's medical care.

3.3. Tools

We developed a questionnaire for data collection, consisting of three sections, plus a final part referring to psychological variables (perceived health and worry about loss of

[2] Samples of the videos are available at the web site: http://robocare.istc.cnr.it/

cognitive competence) and socio-demographics. The sections are briefly presented below:

Section 1. Eight fill-in papers, each of them referring to one of the eight scenarios, were presented. For each scenario, questions about the likelihood of the situation for the elderly person, the utility and acceptability of the robot were asked.

Section 2. An attitude scale, consisting of 45 Likert-type items, referring to the physical aspect of the robot, interactive behavior and communication modalities, the level of integration with the domestic environment, the degree of perceived intrusion/disturbance of the robot in everyday life and routines, the personal advantages and disadvantages of having such a device at home.

Section 3. An emotional scale, consisting of sixteen adjectives through which respondents have to evaluate the possible presence of the robot in their home.

Section 4. Two Likert-type items were presented, referring to perceived health ("On the whole, how much are you satisfied with your health conditions?") and worry about loss of cognitive competence ("How much are you afraid of cognitive impairments associated to aging?"). Finally, we asked socio-demographic data.

In Sections 1 and 4, respondents had to express their evaluations on a scale ranging from 0 ("Not at all") to 4 ("Very much"). In Sections 2 and 3, respondents had to express their level of agreement/disagreement on a scale ranging from 0 ("I totally disagree") to 4 ("I completely agree").

3.4. Participants and Procedure

We recruited forty elderly people (aged 56-88; mean age = 70.3 years) for this exploratory study. Participants were 13 males and 27 females; as for their educational level, 17.9% attended primary school, 43.6% attended middle school, 25.6% attended high school, and 12.9% have a degree. Most of them (82.5%) are retired. Before retirement, 22.5% were teachers, 15% were office workers.

Subjects were randomly assigned to one of the two experimental conditions (Face/No-face). In order to control for the potential influence of administration procedure on results, the movies were either projected on a notebook monitor, in a face-to-face administration, or on a larger screen, in a small-group administration. In addition, two different sequences of presentation of scenarios were employed, in order to avoid an order effect of episodes on results. After the vision of each scenario, participants were asked to fill the paper specifically referring to it (Section 1 of the questionnaire). At the end of the whole presentation, subjects were asked to give

general evaluations of the robot (Sections 2 and 3 of the questionnaire), and to fill the final part of the questionnaire (Section 4), referring to psychological variables and socio-demographics.

4. Results

A variety of quantitative analyses (ANOVA, Chi-square and Pearson's correlation) were conducted for this study and integrated with a more qualitative evaluation of the user's responses.

First, we checked for the possibility of an influence of procedure administration on judgements. Results from the monitor and the small-group administration were compared, and no significant difference emerged between procedures with respect to all areas of evaluation we considered.

Then, preliminary analyses were performed in order to assess the effectiveness of our selection of scenarios as meaningful in elderly people's experience. On the whole, results showed that proposed scenarios were significant in everyday life of respondents (M = 2.38, sd = .55), and the RDE's support was evaluated as both useful (M = 2.43, sd = .75) and appreciated (M = 2.32, sd = .75). In particular, we found a higher level of perceived utility for Personal safety (M = 3.10, sd = 1.01), and a lower level for Suggestions (M = 1.85, sd = 1.14). A more detailed analysis of scenarios, specifically focussing on the difference between On-demand and Proactive situations is discussed in Cesta, Cortellessa, Pecora, & Rasconi (2007).

4.1. Acceptability Requirements

General evaluation of the robot. Mean scores referring to key features of the robot (physical aspect, interactive behaviour and communication modalities, integration with the home, potential intrusion/disturbance in everyday routines, personal advantages provided) were calculated. On the whole, the robot emerged to be positively evaluated with respect to physical aspect (M = 2.21, sd = .78), interactive behaviour and communication modalities (M = 2.37, sd = .61), level of integration with the domestic environment (M = 2.34, sd = .91), absence of perceived intrusion/disturbance in everyday life and routines (M = 2.50, sd = 1.10), and personal advantages of having such a device at home (M = 2.27, sd = .65).

Similarity to human beings. A comparison between experimental conditions showed a stronger preference for the No-face version of the robot (see Figure 3). In particular, a significant difference in favour of the No-face robot emerged with respect to physical aspect ($F_{(1,38)} = 7.45$, $p < .01$), integration with the home environment ($F_{(1,38)} = 5.65$, $p < .05$), advantages provided by the robot at home ($F_{(1,38)} = 4.58$, $p < .05$). No significant difference between the Face and the No-face versions emerged with reference to interactive behaviour and communication modalities ($F_{(1,38)} = .97$, n.s.) and level of perceived intrusion/disturbance ($F_{(1,38)} = 1.55$, n.s.).

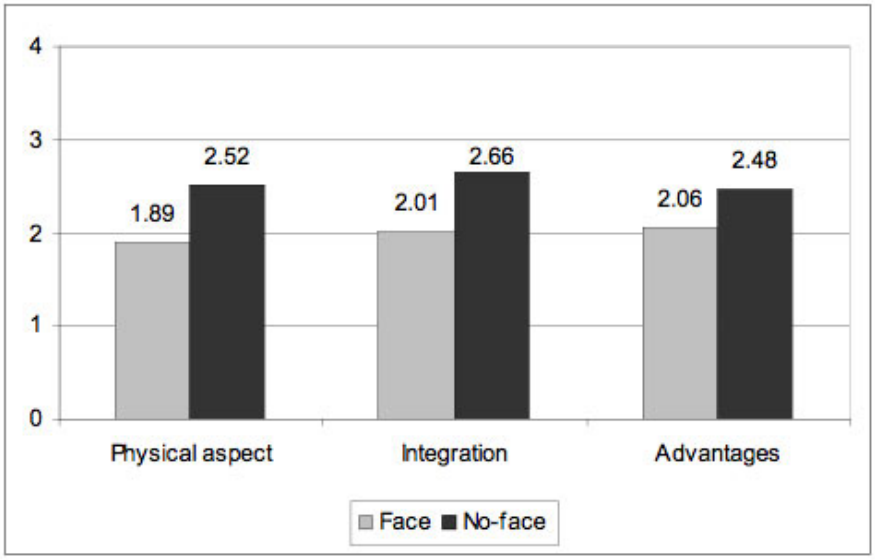

Figure 3. Evaluation of the Face and No-face robot.
Users were asked to evaluate on a scale from 0 to 4.

In addition, elderly people seemed to be more likely to develop a psychological attachment towards the No-face robot than towards the Face robot ($\chi^2 = 6.11$, $df = 2$, $p < .05$).

Influence of psychological variables. Our analyses outlined a clear influence of both perceived health and worry about loss of cognitive competence on evaluations expressed by elderly people.

The level of perceived health did not show any influence on utility and acceptability of the robot in the evaluation of scenarios. Conversely, elderly people perceiving better health conditions expressed more positive evaluations about the integration of the robot in the domestic environment ($F_{(1,38)} = 4.11$, $p < .05$), and the level of intrusion/disturbance of the robot in everyday life and routines ($F_{(1,38)} = 4.54$, $p < .05$)

than elderly people complaining for worst health conditions (see Fig. 4). No significant difference emerged with respect to physical aspect ($F_{(1,38)}$ = .50, n.s.), interactive behaviour and communication modalities ($F_{(1,38)}$ = 1.31, n.s.) and advantages provided by the robot at home ($F_{(1,38)}$ = 1.55, n.s.).

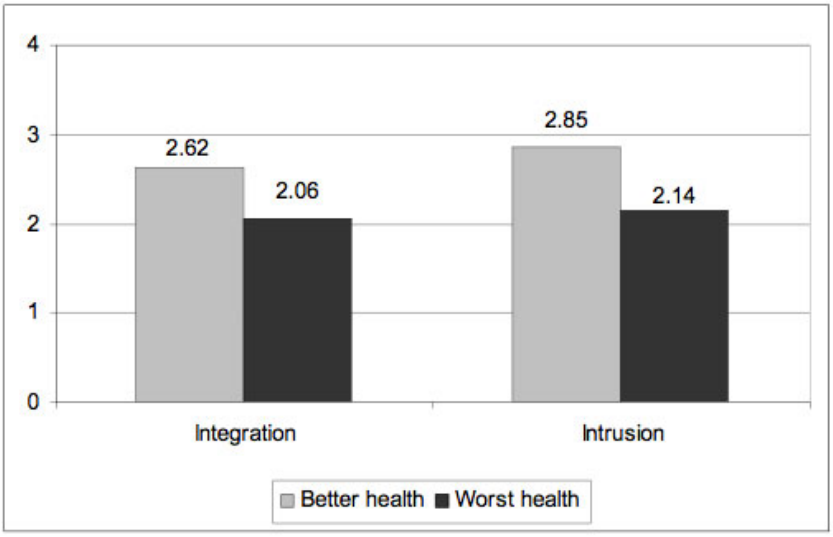

Figure 4. Influence of perceived health conditions.
Users were asked to evaluate on a scale from 0 to 4.

In particular, the perception of better health conditions was found to lead to a more positive evaluation of the robot's ability to move without crashing objects ($F_{(1,38)}$ = 6.07, $p < .05$), a stronger personal willingness to teach the robot what to do at home ($F_{(1,38)}$ = 7.89, $p < .01$), a higher preference for the possibility for the robot to autonomously give suggestions ($F_{(1,38)}$ = 4.68, $p < .05$) and take decisions ($F_{(1,38)}$ = 4.64, $p < .05$).

In addition, elderly people perceiving better health conditions showed a more positive emotional reaction to the robot, being it evaluated as less scary ($F_{(1,38)}$ = 4.46, $p < .05$) and cumbersome ($F_{(1,38)}$ = 7.75, $p < .01$)

Interestingly, elderly people perceiving better health conditions were also more confident to have the robot available in the market in the near future ($F_{(1,38)}$ = 5.92, $p < .05$).

Personal worry about loss of cognitive competence showed a significant influence on utility and acceptability of the robot in the evaluation of scenarios. Elderly people showing a stronger apprehension for personal cognitive impairments expressed more positive evaluations on both variables with reference to Finding objects ($F_{(2,37)}$ = 5.68, $p < .01$ for utility and $F_{(2,37)}$ = 3.30, $p < .05$ for acceptability, respectively), Reminding analyses ($F_{(2,37)}$ = 3.95, $p < .05$ for utility and $F_{(2,37)}$ = 3.88, $p < .05$ for acceptability,

respectively), Activity planning ($F_{(2,37)}$ = 9.92, p < .01 for utility and $F_{(2,37)}$ = 8.55, p < .01 for acceptability, respectively), Suggestion ($F_{(2,37)}$ = 3.48, p < .05 for utility and $F_{(2,37)}$ = 7.93, p < .01 for acceptability, respectively), and Reminding events ($F_{(2,37)}$ = 14.33, p < .01 for utility and $F_{(2,37)}$ = 20.99, p < .01 for acceptability, respectively), on utility with reference to Environmental safety ($F_{(2,37)}$ = 4.33, p < .05), and on acceptability with reference to Reminding medication ($F_{(2,37)}$ = 4.85, p < .05).

Moreover, elderly people showing higher anxiety about cognitive impairments expressed more positive evaluations about the physical aspect of the robot ($F_{(2,37)}$ = 5.11, p < .05), interactive behaviour and communication modalities ($F_{(2,37)}$ = 4.45, p < .05) and advantages provided by the robot at home ($F_{(2,37)}$ = 6.54, p < .05) (see Fig. 5). No significant difference emerged with respect to integration of the robot in the domestic environment ($F_{(2,37)}$ = 2.88, n.s.), and the level of intrusion/disturbance of the robot in everyday life and routines ($F_{(2,37)}$ = 2.10, n.s.).

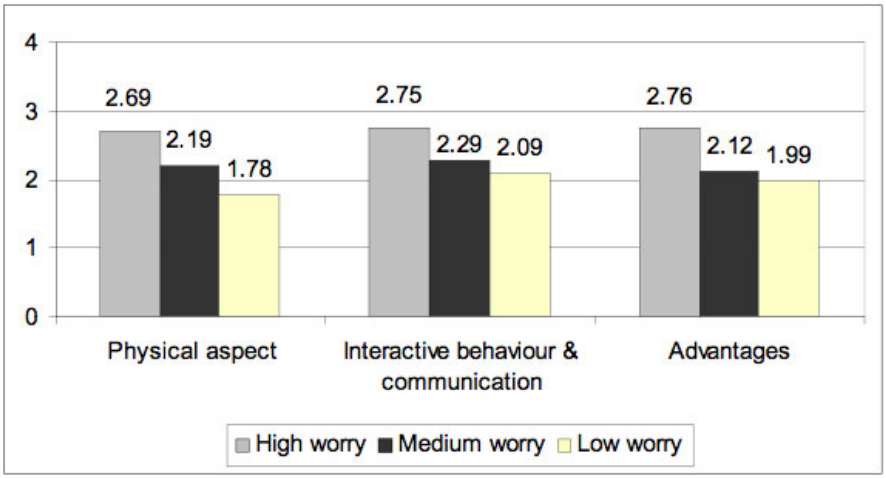

Figure 5. Influence of worry about cognitive impairments. Users were asked to evaluate on a scale from 0 to 4.

In particular, elderly people worrying the most about a personal cognitive weakening showed a stronger confidence that the robot would make people feel tranquil at home ($F_{(2,37)}$ = 3.63, p < .05), a greater satisfaction for the possibility of a face-to-face ($F_{(2,37)}$ = 4.74, p < .05) and a direct speech ($F_{(2,37)}$ = 5.58, p < .01) interaction, a stronger agreement on positive cognitive support ($F_{(2,37)}$ = 3.36, p < .05) and help in everyday life management ($F_{(2,37)}$ = 4.46, p < .05) provided by the robot, and a lower apprehension for its maintenance ($F_{(2,37)}$ = 5.90, p < .01) than people with a lower level of anxiety about the loss of cognitive competence. Interestingly, they would also like more to train their cognitive competence by actively interacting with the robot ($F_{(2,37)}$ =

12,46, $p < .01$) than people with lower apprehension. On the other hand, users seemed to be aware of a potential dependence on the robot in certain cognitive tasks ($M = 2.48$, $sd = 1.45$).

Furthermore, the elderly who showed a higher apprehension for the weakening of cognitive competence expressed a more positive emotional reaction to the robot, being the agent perceived as more pleasant ($F_{(2,37)} = 9.09$, $p < .01$), useful ($F_{(2,37)} = 6.98$, $p < .01$) and dynamic ($F_{(2,37)} = 3.57$, $p < .05$), and less overwhelming ($F_{(2,37)} = 4.06$, $p < .05$), dangerous ($F_{(2,37)} = 4.37$, $p < .05$), scary ($F_{(2,37)} = 3.68$, $p < .05$), worrying ($F_{(2,37)} = 4.60$, $p < .05$), and out of control ($F_{(2,37)} = 3.60$, $p < .05$).

Elderly people showing a stronger anxiety about the loss of cognitive competence were also more confident to have the robot available in the market in the near future ($F_{(2,37)} = 4.35$, $p < .05$).

5. Discussion and Conclusions

The study allowed us to get some light on elderly people-assistive robotic technology interaction. First of all, we had some insights on how useful and accepted state-of-the-art assistive technology can be in real situations. Moreover, we got significant indications as to whether we are employing this technology to solve real needs felt by final users.

Overall, even if Cesta, Cortellessa, Pecora, & Rasconi (2007) showed the central role of safety in elderly people's experience, being the perceived utility of and the expressed preference towards a proactive robot intervening in case of an emergency higher, a positive reaction to different interactive situations was undoubtedly found. This picture is in line with the model of successful aging put forward by Baltes and Baltes (1990), in which the importance of selection and optimization of activities with increasing age was recognized. In addition, it showed the key role of compensation strategies to manage the loss of personal resources. Even though elderly people do not think that a robotic agent living in the domestic environment can be so useful for uncompelling activities as for safety, nonetheless they do not perceive it as completely out of place when supporting the former. This result shows an openness of elderly people towards a variety of functionalities, at least to some extent: they may be rather unfamiliar with some kind of supportive capabilities of the RDE, but not against them a priori. This can get an optimistic light on developments in the range of activities

potentially performed by robotic agents, even though a more accurate understanding of psychological implication of user-RDE interaction in situations that do not involve safety is still needed.

In this respect, a clear difference emerged when comparing our results with other studies concerning evaluations of a domestic robot (Scopelliti, Giuliani, D'Amico, & Fornara, 2004), thus supporting the need for analyses in real environments: elderly people are not afraid of the robot's autonomy anyway, and the idea of the robot as a possible source of intrusion/disturbance in personal life, as depicted in previous research (see Scopelliti, Giuliani, & Fornara, 2005) did not emerge. Conversely, the elderly show more positive reactions and evaluations when it is possible to see clearly what a robot can actually do in the domestic environment. Beyond scenarios analysis, this picture is outlined also in the general assessment of the robot, which showed to be rather positive throughout the different areas of investigation. In other words, a representation grounded on unrealistic ideas (as the ones proposed by science fiction) may negatively bias attitudes and expectations.

The physical aspect of the robot emerged to be an important feature which can help support acceptability, and resemblance to human beings plays a key role to this issue. In particular, the No-face version of the robot was definitely preferred, and, interestingly, this physical feature emerged to influence also the evaluation of other characteristics that one might consider as apparently unrelated. In fact, the No-face robot was perceived as better integrated in the home setting and more valued as a source of advantages in the management of everyday life. Beyond evaluations, the No-face robot also showed to promote a deeper emotional involvement in elderly users, expressed in terms of psychological attachment to the assistive agent. Briefly, the better the aspect, the stronger the perception of positive qualities attributed to the robot and the affective bonds. This suggests the occurrence of a halo effect, consistently emerging in social sciences with reference to personality judgements (e.g., Asch, 1946). The possibility to develop a psychological attachment toward this kind of assistive technology is also confirmed by Turkle, Taggart, Kidd and Daste (2006), who showed how, even with simple relational artefacts, the possibility for significant attachment is very high and increases when considering relational artefacts with more complex capabilities. This issue, in turn, raises ethical concerns that are no longer avoidable when designing assistive robots. While the ethical issue has not been addressed within our study it is important to highlight how it is increasingly becoming a

matter for both public policy debate (Barry, 2005) and research studies (Calverley, 2006).

The study also highlighted the relevance of some psychological variables in moderating the assessment of the robotic agent. In particular, the perception of one's health conditions being better or worst definitely plays a key role. Elderly people perceiving worst health conditions, hence presumably being more in need for some kind of support at home, are those who showed more negative evaluations of the robot, which is considered as less integrated in the domestic environment and a potential source of intrusion/disturbance in everyday life; likewise, it is worth noting that they do recognize the practical advantages of having such a device at home. This result probably shows a peculiar representation of the robotic agent by this group of users, according to which the perception of personal frailty leaves them weaker in case of difficulties. What if the robot should crash objects while moving? What if the robot is unable to do what people need? What if it autonomously takes decisions? In this light, practical advantages potentially granted by the robot are not denied, but simply undervalued when compared to personal demands for its management. Accordingly, they are more scared by the robot and find it somewhat cumbersome.

Beyond how elderly people feel at the moment, also the way they perceive their conditions with further ageing emerged to influence the evaluation of the robot. In this respect, the apprehension for cognitive impairments definitely showed to play a key role. Briefly, the more the worry for cognitive weakening, the more positive the assessment of the robot's capability and the general reaction towards it. For those people who have a stronger concern for cognitive weakening, the perceived utility and acceptability of the robot dramatically increase in evaluations of domestic situations/activities specifically referring to the use of memory and cognitive resources. Moreover, they appreciate much more the variety of practical supports in everyday life management, which can make them live more relaxed, but also other features of the robot, which have mainly to do with its interactive behaviour and communication modalities. This clearly identifies cognitive competence as one of the most important resources to maintain well-being from the elderly point of view. With increasing age and the natural weakening of this resource, the use of environmental coping strategies implying assimilation (Brandtstadter & Renner, 1990; Slangen-de Kort, Midden & van Wagenberg, 1998; Giuliani, Scopelliti, & Fornara, 2005) is likely to be the most suitable way of adaptation when related activities are of central importance. From a psychological point of view, what seems to be of greatest importance is that elderly

people seem to forecast a potential loss in personal autonomy depending on the robot, which may lead them to reduce perceived competence and self-efficacy (Bandura, 1977), key factors for a successful ageing of people (Lawton, 1982; McAvay, Seeman, & Rodin, 1996; Willis, 1996). In this respect, they showed to appreciate the possibility to interact with the robot not only passively relying on its capabilities, but also through an active training to enhance their cognitive functioning. Beyond the cognitive component of their attitude, the positive evaluation of the robot and its capabilities is also associated to a more positive emotional reaction and, interestingly, a stronger confidence (or desire) to have such a device soon available.

Finally, some shortcomings of the study should be mentioned. First of all, given the exploratory purpose of this study, we performed a large number of analyses and it is possible that some results are significant only by chance (namely, an inflation of error rate). In this respect, internal validity could be increased by a larger sample of elderly people. This would also give the opportunity to perform different and more complete statistical analyses. For example, through a factor analysis it would be possible to identify a smaller number of macro-dimensions of elderly people-robot interaction which are relevant in the users' experience, and to perform comparisons with reference to them. This would dramatically reduce the possibility for an inflation of error rate to occur. Second, our study presumably lacks external validity, in that our respondents were rather well-educated and generally in good health conditions: when people are in a condition of actual need, the evaluation of a robotic agent supporting the elderly with age-related impairments may presumably be different.

Nonetheless, our findings can be considered an intriguing starting point to address the issue of acceptability of robotic agents in everyday life of elderly people, and to guide future research on this topic. On the one hand, the role of a domestic robot in the everyday experience of elderly people clearly emerged. In their eyes, the robot is perceived as a practical device, with one physical key feature: it should not resemble a human being. On the other hand, a face-to-face interaction is definitely preferred presumably in order to reduce the emotional distance from the agent. In this respect, it would be interesting to evaluate in further research the potential response of users to a domestic assistive device which cannot move about in the environment. An environmental system equipped with software, sensory and speaking services would probably be able to perform the same activities provided by the robotic agent shown in this study, but acceptability might be significantly influenced by such a difference.

Overall, our study wants to suggest the importance of employing experimental procedures involving real users and referring to real-life situations in order to get helpful guiding principles for further developments of robotic assistive technology for the elderly in the home environment.

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7. References

Asch, S. E. (1946). Forming impressions of personality. *Journal of Abnormal and Social Psychology*, *41*, 258-290.

Baltes, P. B., & Baltes, M. M. (1990). Psychological Perspectives on Successful Aging: The Model of Selective Optimization with Compensation. In P. B. Baltes & M. M. Baltes (Eds.), *Successful aging: Perspectives from the behavioral sciences* (pp. 1-34). New York: Cambridge University Press.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioural change. *Psychological Review*, *84*, 191-215.

Barry, B. (2005). Better than people: why the Japanese want their robots to act more like humans. *The Economist,* 24. Retrieved December 19, 2007, from http://www.economist.com/world/asia/displaystory.cfm?story_id=E1_VPNPQNS.

Brandtstadter, J., & Renner, G. (1990). Tenacious goal pursuit and flexible goal adjustment: Explications and age-related analysis of assimilation and accommodation strategies of coping. *Psychology and Aging*, *5*, 58-67.

Calverley, D. J. (2006). Android science and animal rights, does an analogy exist? *Connection Science*, *18*(4), 403-417.

Cesta, A., Cortellessa, G., Giuliani, M., Pecora, F., Rasconi, R., Scopelliti, M., & Tiberio, T. (2007). Proactive assistive technology: An empirical study. In M. C. Calani Baranauskas, P. A. Palanque, J. Abascal, S. Diniz Junqueira Barbosa

(Eds.), Human-Computer Interaction - INTERACT 2007. *Lecture Notes in Computer Science* (*LNCS)4662*, (pp. 255-268). Berlin, Heidelberg: Springer.

Cesta, A., Cortellessa, G., Pecora, F., & Rasconi R. (2007). Supporting Interaction in the RoboCare Intelligent Assistive Environment. In *Proceedings of AAAI Spring Symposium on Interaction Challenges for Intelligent Assistants* (pp. 18-25) Stanford: AAAI.

Cesta, A., & Pecora, F. (2006). Integrating Intelligent Systems for Elder Care in RoboCare. In W. C. Mann & A. Helal (Eds.), *Promoting Independence for Older Persons with Disabilities* (pp. 65-73). Amsterdam: IOS Press.

Cortellessa, G., & Cesta, A. (2006). Evaluating Mixed-Initiative Systems: An Experimental Approach. In *Proceedings of the 16th International Conference on Automated Planning & Scheduling, ICAPS-06* (pp. 172-181). The English Lake District, UK: AAAI.

Delbaere, K., Crombez, G., Vanderstraeten, G., & Willems T. Cambier, D. (2004). Fear-related avoidance of activities, falls and physical frailty. A prospective community-based cohort study. *Age and Ageing*, *33*(4), 368-373.

Feil-Seifer, D., & Mataric', M. J. (2005). Defining socially assistive robotics. In *Proceedings of the 9th International Conference on Rehabilitation Robotics* (ICORR-05) (pp. 465-468). Chicago, IL: IEEE.

Fong, T., Nourbakhsh, I., & Dautenhahn, K. (2003). A survey of socially interactive robots. *Robotics and Autonomous Systems*, *42*(3-4), 143-166.

Giuliani, M. V. (1991). Toward an analysis of mental representations of attachment to the home. *The Journal of Architectural and Planning Research*, *8*, 133-146.

Giuliani, M. V., Scopelliti, M., & Fornara, F. (2005). Elderly people at home: technological help in everyday activities. In *IEEE International Workshop on Robot and Human Interactive Communication* (ROMAN 2005) (pp. 365-370). Nashville: IEEE.

Hutchins, E. (1995). *Cognition in the Wild*. Cambridge, MA: MIT Press,.

Lawton, M. P. (1982). Time budgets of older people: A window on four lifestyles. *Journal of Gerontology*, *37*, 115-123.

Li, F., Fisher, K. J., Harmer, P., McAuley, E., & Wilson, N. L. (2003). Fear of falling in elderly persons: Association with falls, functional ability, and quality of life. *Journal of Gerontology Series B: Psychological Sciences and Social Sciences*, *58*(5), 283-290.

McAvay, G. J., Seeman, T. E., & Rodin, J. (1996). A longitudinal study of change in domain-specific self-efficacy among older adults. *Journal of Gerontology*, *51*, 243-253.

Myers, K. (2006). CALO: Building an intelligent personal assistant. Invited talk at the *Twenty-First National Conference on Artificial Intelligence* (AAAI-06), July 16-20, 2006, Boston, Massachusetts. Slides retrieved on December 6, 2007 from http://caloproject.sri.com/publications/.

Pecora, F., Rasconi, R., Cortellessa, G., & Cesta, A. (2006). User-Oriented Problem Abstractions in Scheduling, Customization and Reuse in Scheduling Software Architectures. *Innovations in Systems and Software Engineering*, *2*(1), 1-16.

Pineau, J., Montemerlo, M., Pollack, M., Roy, N., & Thrun, S. (2003). Towards Robotic Assistants in Nursing Homes: Challenges and Results. *Robotics and Autonomous Systems*, *42*(3-4), 271-281.

Pollack, M. E. (2005). Intelligent Technology for an Aging Population: The Use of AI to Assist Elders with Cognitive Impairment. *AI Magazine*, *26*(2), 9-24.

Rockwood, K. (2005). Frailty and its definition: A worthy challenge. *Journal of the American Geriatrics Society*, *53*(6), 1069-1070.

Rockwood, K., Howlett, S. E., MacKnight, C., Beattie, B. L., Bergman, H., Hébert, R., Hogan, D. B., Wolfson C., & McDowell, I. (2004). Prevalence, Attributes, and Outcomes of Fitness and Frailty in Community-Dwelling Older Adults: Report From the Canadian Study of Health and Aging. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *59*, 1310-1317.

Rowles, G. D., & Chaudhury, H. (2005). *Home and Identity in Later Life. International Perspectives* . New York: Spring Publishing Company.

Sabanovic, S., Michalowski, M. P., & Simmons, R. (2006). Robots in the wild: Observing human-robot social interaction outside the lab. In 9th *IEEE International Workshop on Advanced Motion Control* (pp. 596 - 601). Istanbul: IEEE.

Scopelliti, M., Giuliani, M. V., D'Amico, A. M., & Fornara, F. (2004). If I had a robot ... Peoples' representation of domestic robots. In S. Keates, P. J. Clarkson, P.M. Langdon, & P. Robinson (Eds.), *Design for a more inclusive world* (pp. 257-266). London: Springer-Verlag.

Scopelliti, M., Giuliani, M. V., & Fornara F. (2005). Robots in a domestic setting: A psychological approach. *Universal Access in the Information Society*, *4*(2), 146-155.

Slangen-de Kort, Y. A. W., Midden, C. J. H., & van Wagenberg, A. F. (1998). Predictors of the adaptive problem-solving of older persons in their homes. *Journal of Environmental Psychology*, *18(2)*, 187-197.

Strandberg, T. E., & Pitkälä, K. H. (2007). Frailty in elderly people. *The Lancet*, *369*, 1328-1329.

Tapus, A., Mataric', M. J., & Scassellati, B. (2007). The grand challenges in socially assistive robotics. *IEEE Robotics and Automation Magazine*, *14*(1), 35-42.

Turkle, S., Taggart, W., Kidd, C. D., & Daste, O. (2006). Relational artifacts with children and elders: The complexities of cybercompanionship. *Connection Science*, *18*(4), 347-361.

Willis, S. L. (1996). Everyday cognitive competence in elderly persons: Conceptual issues and empirical findings. *The Gerontologist*, *36*, 595-601.

Zijlstra, G. A. R., van Haastregt, J. C. M., van Eijk, J. T. M., van Rossum, E., Stalenhoef, P. A., & Kempen, G. I. J. M. (2007). Prevalence and correlates of fear of falling, and associated avoidance of activity in the general population of community-living older people. *Age and Ageing*, *36*(3), 304-309.

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Simple, Fast, Cheap: Success Factors for Interactive Multimedia Tools

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ABSTRACT

This paper discusses key factors contributing to the "success" of interactive multimedia development tools in non ICT professional contexts. We define "success" in terms of acceptability and large scale usage by entities and institutions who may need to build interactive multimedia artifacts but do not have technical competences "in-house" and must cope with very limited financial resources. Schools or museums, for example, may want to exploit interactive multimedia for communication or educational purposes, but are bound to many resource-related constraints. In this perspective, we argue that simplicity, low-cost, and ultra short "time-to-market" are key requirements for interactive multimedia development tools to be accepted and widely adopted by non ICT professionals. To support his claim, we illustrate an exemplary tool that meets these requirements and was developed at our lab within the Policultura Project. The tool was successfully used by cultural heritage experts in Italian small museums and by over 1300 students of 55 schools in Italy, and brought important educational and social benefits to all stakeholders involved.

Keywords: *Interactive multimedia, Storytelling, Hyperstory, Design Pattern, Simplicity, Learning.*

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1. Introduction and Motivation

In this paper, we will discuss the success story of a project that has attempted to make simple, fast, and cheap the process of developing and delivering an interactive multimedia on different interaction channels.

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We describe a toolkit that was developed at our lab and is called 1001stories – a name inspired by "The book of One Thousand and One Nights", the well known collection of tales compiled over thousands of years by various Persian, Arab and Turk authors, translators and scholars since 800-900 A.D.

1001stories enables people to easily shape an interactive multimedia artifact as a "hypermedia story" (a non linear narrative that exploits a variety of media: text, audio, images, videos, animations (Joyce, 1997; Mallowy & Marshall, 1996) and to deliver it on different channels , so that people can enjoy the hyperstory in different physical settings and situations, both on-line and off-line: through the web (e.g., at home, in the office, in the computer rooms at school or in a museum), through a CD-ROM (e.g., on a museum kiosk or in the classroom), and through a mobile device like the iPod™ (for mobile use "on the go", walking, in the metro, on the bus, or in the park).

The 1001stories toolkit was mainly developed within the Policultura project (www.policultura.it) – an initiative supported by Politecnico di Milano that aims at fostering the adoption of ICT technology in Italian schools and promoting a "polycultural" approach to education in which technology and humanities are smoothly and synergistically combined.

1001stories toolkit is composed by two main ingredients: (a) a hyperstory development tool, allowing for an efficient content data entry and the fast generation of the multimedia interactive application; (b) a methodological guidance, which supports an organized development process and provides a "proposed workflow", i.e., a structured collection of activities and content production guidelines to build a hyperstory in an efficient way.

It is important to note that 1001stories has been conceived as a tool for non multimedia professionals. We want to have hyperstory creators focus on the design of "the message" and on the quality of the contents and narratives ("what do I want to say") – which represent the key success factors for the overall quality of the user experience – rather than on technology and implementation ("how do I make it happen"). We want to have them investing the main effort on content decisions, content creation/ production/revision, product evaluation and quality assurance; we want that a professional development team does not have to take any major technological decisions (about software architecture, databases, programming language etc.) and does not have to invest a penny in implementation. Ultimately, we want to foster vision of the hyperstory development process in which the crucial competencies required in

the production team mainly concern domain-knowledge, aural and written communication, rather than technology.

Our thesis is that simplicity, low-cost, and fast development are crucial factors for the success of a toolkit like ours, if we "measure" success in terms of the degree of acceptability and usage by the intended target. In the paper, we will also report some key results of an extensive field study that was carried on to identify the benefits of our approach and that empirically support the above thesis.

2. Scoping "Storytelling" for 1001Stories

The term "story" is quite wide and virtually encompasses any discursive narrative that generates and sustains meaning.

Huge is the literature on storytelling as a paradigm for effective communication to be used in a variety of contexts and domain, from art, literature, entertainment, to business life (Bruner, 2002; Glassner, 2004; Crawford, 2004). Story contents may be fictional or real, may relate to a subjective experience or to more objective facts and events. Some stories are meant to be forms of poetry and art, others to entertain, relax, raise curiosity, inform, advise, warn, provoke, transmit values, preserve traditions, or educate.

Although we are not addressing any specific domain, the hyperstories we mainly support in our project are means of education and learning, information, preservation of culture and traditions, communication of a (cultural, societal, or historical) message, or transmission of values. We do not focus here on the social value of storytelling but rather on supporting efficient technology-enhanced storytelling development by providing a simple technological and editorial framework that allows to shape stories with a predefined, but yet open and very generic structure. The target of the hyper-storytelling development tool discussed in this paper includes anyone who wants to build hyperstories having the above goals, but possesses a very scarce technical know-how, very limited budget and time constraints. This is the typical case, for example, of small cultural heritage institutions (e.g. local museums) or tourism organizations, schools, companies, who may adopt a storytelling approach to communicate events, places, projects, personal or social experiences.

3. The 1001STORIES Toolkit

3.1. The Development Tool

The 1001stories toolkit supports the process of i) translating conceptual narrative structures into a suitable interactive digital format; ii) filling them with multimedia contents, and iii) delivering the resulting hyperstory on different channels. The tool is fast to learn, quick in enabling the delivery of a complete multimedia hyperstory, and easy to use, hiding the complexity of the implementation underlying the tool.

Everything from building the narrative structures to inserting or updating multimedia contents in the narrative units, to page publishing to CD-ROM compilation to podcasting is intuitive and can be done with few clicks.

Our main purpose is to make this overall process as simple, cheap, and fast as possible. We call this approach “instant multimedia” (Di Blas, Bolchini & Paolini, 2007) – a term is inspired by the notion of “instant books”, coined in the world of publishers to denote traditional (i.e., paper based) editorial products of good quality that can be put on the market in a very short time (1-2 months) and at low cost. Our belief is that satisfying these requirements is strategic to be successful in the multimedia publishing area today. In a fast evolving market, it might be better for companies or institutions or organizations to produce several low-cost productions in a fast way (in 3-4 weeks), rather than a few expensive ones, perhaps much later (in 8-10 months). Small, lean, low cost, hypermedia products can be targeted to different niches of potential users, and/or can deal with several niches of content. Small, fast productions allow institutions or companies or organizations to react quickly to fresh needs or to catch new opportunities presented by different circumstances and events – e.g., exhibitions for museums, fairs for companies, launch of a brand or new products or service, “just-on-time” promotional tools. Finally, multimedia productions tend to quickly become obsolete (or at least, not tuned to current user expectations); this is a major problem for large productions that can't be easily redone, while is a minor problem for small low-cost productions that can more easily be discarded and redone.

In software engineering terms, the 1001Stories tool can be defined as a web-enabled application framework (Ceri, Florian, Matera, & Facca, 2007; Fayad, 2000; Garzotto & Megale, 2005; Mori, Paternò, & Santoro, 2004; Schwabe, Rossi, Emeraldo, & Lyardet, 1999) (www.webratio.com) for multichannel hypermedia storytelling. An application framework “…provides a reusable solution for a class of software applications that share a common set of requirements. It can be regarded as an application “skeleton”,

which captures the essential features of a family of applications and can be customized to produce a specific application in the family" (Garzotto & Megale, 2006; Meyrowitz, 1986). Still, differently from existing software engineering frameworks, which are traditionally conceived as tools for programmers, 1001Stories shifts the perspective from programmers to non-programmers - persons with very limited technological capability. In this respect, 1001stories implements the concept of end-user development, which promotes the idea of "…enabling also non computer professionals…to build new computer based applications without ever seeing the underlying program code" (Sutcliffe & Mehandjiev, 2004).

The tool implements a pattern-based approach, supporting a pre-defined information architecture, a set of built in navigation and interaction patterns, and a set of lay-out templates (Antle, 2003; Garzotto, Paolini, Bolchini, & Valenti, 1999).

According to the 1001Stories pattern, a story is composed by topics, where each topic represents a "step" or a "bit" of a story. Each topic contains sub-topics that represent further details on the topic. Starting from a cover page (or homepage), the user can explore the story in different ways: s/he can access each topic from the homepage, or sequentially visit (through a guided tour pattern) each topic from the first to the last. While in each topic, the user can sequentially or directly visit each subtopic, and then pass to the next topic.

Automatic loop navigation is also offered, to enable the user to just relax and listen and watching to all the story topics and subtopics in sequence without need of further interaction.

The 1001Stories tool enables a non-computing specialist to easily produce a story based on this structural pattern, as s/he is asked to cater "only" for the story content (texts and images), since the information architecture and navigation mechanisms are already built-in.

In essence, the functionality offered by the 1001Stories tool to easily build and publish a story can be summarized in three main features (Figure 1): Data Entry, Preview and Generator.

Figure 1. 1001Stories management interface.

The *Data Entry* is a simple control panel enabling the user to edit the editorial plan of the story (i.e. decide the steps of the story), to enter content for each element (i.e. title, text, images with captions and audio file), and to perform all needed changes.

The *Preview* allows to visualize at any moment of the process the preliminary resulting story (as it will appear to the user) of what has been entered so far. In this way, the developer can immediately check the quality of the story (e.g. the impact of the content, of the graphics) and make the wished improvements.

The Generator produces and publishes the final applications (for the different delivery channels), once every element of the story has been set and specified.

Figure 2 shows examples of a multimedia hyperstory that was built using our tool, delivered on a stationary on-line or off line channel and on i-Pod.

Figure 2. 1001Stories application for stationary channel (web).

3.2. Essential Methodological Guidance

An additional requirement for the 1001Stories project derives from our belief, based on our long standing experience in hypermedia project management, that a good development tool *per se* is not enough to make a development process simple, fast and low-cost. We need to support and guide a development team to answer questions such as: “Which activities are required to design and build a good hyperstory efficiently? How are they organized? How can we build good and engaging content?”

While experienced hypermedia authors and developers may know the answers to these questions based on their professional expertise, the same is typically not true for novices or non hypermedia professionals (e.g., students, teachers, museum experts). To make a development process simple, fast and low-cost for all, a more holistic approach is needed that also addresses wider organizational aspects, complementing the tool with some methodological support. To meet this requirement, we extended the project scope from the mere development of a “good” tool to the creation of a toolkit that includes also a workflow (i.e., a structured collection of activities to build a hyperstory in an efficient way), and a set of content production guidelines for the development team.

An editorial manual has been produced and made available (on www.policultura.it) to support the storytelling developer to produce effective stories using the 1001Stories tool. Note that the manual is not at all a technical manual on “how to use the tool” (there is no need for it, given the high level of usability of the tool), but a guide on the key editorial activities to follow to create good storytelling content and deliver high-quality stories. 10 key editorial activities are the backbone of the methodological support provided by 1001Stories, and are detailed with specific guidelines in (Di Blas, Bolchini, & Paolini, 2007):

1. Gathering the primary material for the stories (1-2 Hours)
2. Defining the Editorial Plan (1-2 Hours)
3. Setting the Visual Communication (3-8 Hours)
4. Writing The Narratives (8-16 Hours)
5. Producing Audio from Texts (4-8 Hours)
6. Producing the First Version (2 Hours)
7. Performing Quality Check (2-4 Hours)
8. Revising Text and Audio (4-8 Hours)
9. Revising Visual Communication (1-4 Hours)
10. Producing the Final Version (2 Hours)

Note that each activity indicates a suggested realistic timeframe to complete it. These guidelines are especially useful for first-time developers, who need not only to quickly publish their story, but also to guarantee a good quality of the delivered application. Since the storytelling author does not have to take any decision concerning the information structure and navigation (1001Stories makes them for her), the author's effort should actually go in choosing the proper content, accurately selecting the pictures, and shaping an engaging and compelling story.

4. The Evaluation Study

4.1. Exploitation Settings

The 1001Stories toolkit has been intensively used by hundreds of people in low-technology contexts (such as small museums and schools), giving us the possibility to experiment its ease of use and its effectiveness. In its early versions, our HOC lab at Politecnico di Milano used it for building 11 hyperstories (as of May 2007), for different clients and purposes: promotion (of HOC activities and of Politecnico activities), cultural tourism for Milanese museums "Pinacoteca Ambrosiana" and "Museo Archeologico", for the ministry of Tourism of Syria, and for 8 cultural ministries of countries in the Mediterranean area. In all these initiatives, the actual project managers and staff who successfully conceived, designed and produced the storytelling applications had mainly a humanistic background (communication, cultural heritage, or literature) and were not skilled in Computer Science or technological disciplines.

As of January 07, 1001Stories has been used for projects delivered for other cultural institutions (e.g. the Herman Hesse Museum near Lugano, Switzerland) and in other national initiatives (in cooperation with the Italian Ministry for Cultural Heritage).

Moreover, it has also been used by 60 students of Communication Sciences at University of Lugano as a basis for content authoring course projects.

A major opportunity for intense evaluation in the school domain happened during school year 2006-2007, when the 1001Stories toolkit has been used as the framework for an Italian national competition involving nearly 3,000 high school students from 10 different Italian regions. The competition was launched among all Italian high schools under the name "Policultura" (www.policultura.it). The initiative was coordinated by our lab at the Politecnico di Milano and sponsored by IBM Italy, Mondadori (the largest publishing company in Italy), Corriere della Sera (the most important Italian

newspaper), the Ministry of Education, the Museum of Science and Technology "Leonardo da Vinci" in Milan, and the Museum of Science History in Florence.

Participants were requested to create, in two months period, a full hyperstory on either the art or the history of their town, using the 1001Stories toolkit.

106 classes from 70 schools located in all Italian regions took part in the competition. A selection of their hyperstories (in Italian) can be visited on the Policultura web site (www.policultura.it).

An additional opportunity for evaluation of 1001Stories in the school domain was offered by a project which involved a primary school in Milan.

4.2. Evaluation Goals

The goal of the evaluation activity was threefold. On the one hand, we aimed at empirically studying the efficacy of the 1001Stories approach, at least in the educational context, and answer to the following questions:

- Is 1001Stories toolkit really usable for our target audience of storytelling developers?
- At which degree does it support fast and low cost hypermedia production?

In addition, we aimed at exploring how ICT inexperienced people – teachers and young students – carry on the development process, identifying patterns of behavior, points of weakness and strength for the overall approach, as well as directions to improve the proposed workflow. Finally, given the specificity of the school context, we wanted to assess the educational benefits that can be achieved by means of a hypermedia production experience like the one carried on for the Policultura Competition.

The evaluation activity was carried on from February 2007 to April 2007. The study involved 70 high-school students from all over Italy, aged 16-18 (i.e., attending the last two years of Italian high school), and an elementary school class of 24 children aged 9-11, from a public institute in Milano. We also involved approximately 2-3 educators per class, for a total of 224 adults. 90% of the schools were non-technical (lyceums) and provided a limited curriculum in informatics. 85% of the classes had no previous experience in multimedia projects. In particular, the class at the elementary school never used the computer lab before for activities other than writing and printing.

4.3. Experimental Design and Methods

In the case of the high-school students of the Policultura project, the task assigned to students was to develop a story from scratch, using 1001Stories toolkit, on a theme at choice (one per class) illustrating an interesting aspect of cultural, artistic, or historical relevance of their town. In the case of the primary school pupils, the task was to develop a story on "*Roman Milan - Milan during the Romans' age*". This topic was selected by the teachers since it was related to a full day class trip – a visit to the Roman ruins in Milan – organized at the beginning of the school year, and the Roman Civilization is a curricular topic in the last year of Italian primary school[1].

As illustrated in the previous sections, the toolkit comprised of the tool (made available as a password protected web application) to be used in class and remotely, and the editorial guidelines. Both technical and editorial assistance from our staff was remotely available throughout the project.

In both evaluation context (high and primary schools), the subjects were asked to form small groups (of 3 or 4) and each group selected a subtopic of the story theme to develop. In the high school, students were totally autonomous, and the teachers' scaffolding was minimal, being limited to a final check of the syntactic correctness of contents.

In the primary school, the structure of the story, i.e., the editorial plan, was built cooperatively in the classroom, using paper and large posters, under the teacher supervision, and was later implemented by the children in the school computer lab using 1001Stories tool. Children retrieved the needed visual material from the Internet, with the guidance of their teachers, or digitalized their own drawings and images from printed books.

We used various evaluation methods and both qualitative and quantitative techniques for data collection and analysis:

Task-based user testing. This method was used to evaluate the usability of the tool (in terms of actual simplicity), and mainly involved the elementary school children using the tool to develop a hyperstory about "Milan in the Roman Times".

Contextual inquiry. We used this method mainly with elementary school children, to understand how students behave and interact with the tool and collaborate among peers during the overall development process. Moreover, we wanted to have a more

[1] "Roman Milan" is accessible online at http://www.policultura.it/kids.htm following the link "Esplora Milano Romana".

precise sense of the technological competency required to complete a hyperstory using our toolkit.

Questionnaire. We designed an online questionnaire for teachers, combining closed and open-ended questions, and made it available to all educators participating in the Policultura competition after they had completed the hyperstory development with their class (the full questionnaire is available as annex at the end of the paper). The goal of the questionnaire was to get information on the development process by high school students, and to get qualitative and quantitative data on the learning benefits perceived by the expert eyes of the teachers.

4.4. Results and Discussion

Simplicity of the tool

The results of our usability evaluation at the elementary school, indicate that the 1001story tool is indeed very simple and can be used without any preliminary training. All users involved were able to complete all tasks in an average time of 17 minute, with a minimum of 12 minute and a maximum of 26. In 85% of the cases, they did not ask for any assistance to instructors and the observers did not intervene in any way.

Without purposefully not providing any instruction on how to user the tool, the kids basically worked by trial-and-errors but the percentage of “errors”, in terms of “wrong” clicks, was quite low (in average, 12% of the overall set of interactions). The empirical tests also confirmed that the only prerequisite for using the tool is the basic capability of using Windows file system, downloading images from the web, text writing, digital audio recording, and importing digital images from a camera.

Simplicity and effectiveness of the process

In Policultura, contextual inquiry and questionnaire results highlight that the overall workflow and the requirements of each activity were easily understood by teachers and students. 98% of questionnaires reported that the availability of a workflow helped to master the complexity of organizing workgroup activities. 95% of participants delivered their hyperstory by the deadline, meaning that the development process of one full-fledged hyperstory in high schools took less than two months.

Patterns of Behavior

An open-ended question in the questionnaire requested teachers to shortly describe how they organized the work, which has helped us identify some common organizational patterns. In summary, in all cases, the process - being a classwork - has been strongly collaborative among students (which is one of the main benefits acknowledged by teachers – see below) and among teachers of different disciplines – technical and humanistic. We could also identify the different criteria that were adopted for allocating development tasks among the students.

Learning benefits

The results of the questionnaire provided the main data to evaluate the learning impact of the hyperstory telling experience. We considered two levels of Bloom's taxonomy of the learning domain (Bloom, Mesia & Krathwohl, 1964): the cognitive level (which involves knowledge and intellectual skills) and the affective level (which involves the manner in which learners deal with things emotionally - feelings, values, appreciation, enthusiasms, motivations, and attitudes).

For learning benefits at the cognitive level, in the questionnaire we focused on two aspects: "getting a deeper understanding of a subject matter" (i.e., the general topic of the hyperstory developed by each class); "improving the teamwork capability"; "improving the capability in informatics". For the educational benefits at the attitude level, we considered: motivation to learning new subjects, willingness and satisfaction in cooperation, enthusiasm for the overall project.

Asked to estimate the overall educational impact of the Policultura experience using a 4 valued scale values scoring [very low, low, good, very good], 66% of teachers scored it very good, and 34% good. We investigated the degree of achievement of each kind of learning benefit with respect to conventional school activities, using a 4 valued scale: -2 ("much lower achievement"), -1 ("much lower achievement"), +1 ("better achievement"), +2 ("much better achievement"). The diagram below reports the aggregated results of teachers' scoring for the various kinds of benefits.

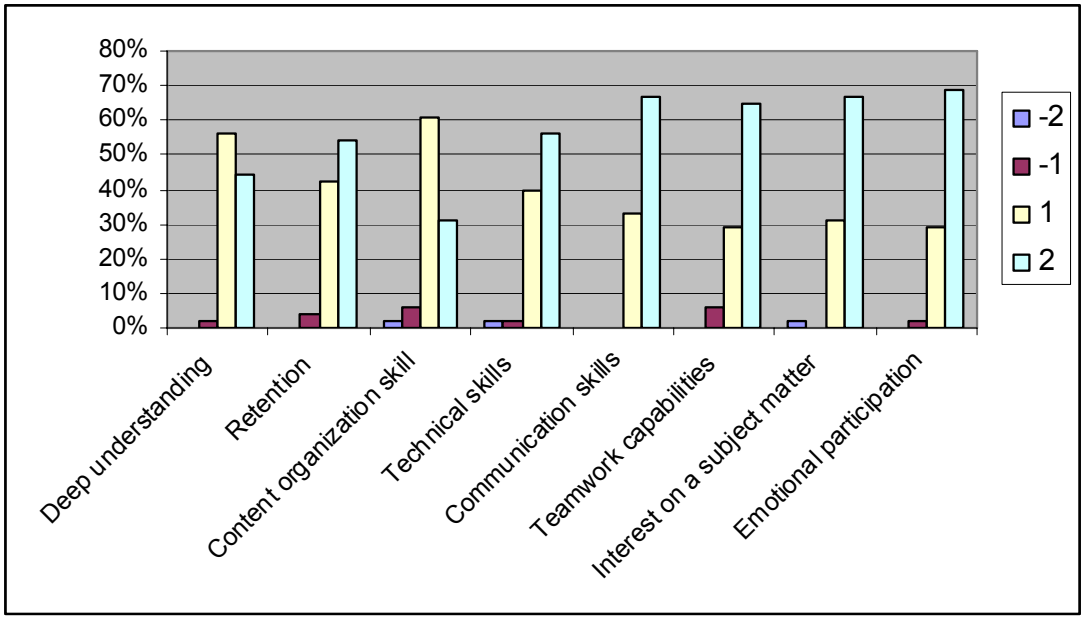

Figure 3. 1001Stories learning benefits as perceived by the teachers in Policultura**.**

The analysis of the questionnaire data highlights a significant educational impact of the experience. More that 50% of the teachers evaluated that the experience induced a much higher achievement of all learning benefits considered, if compared with conventional activities that are carried out at school to address similar learning goals. Finally, a high majority of respondents (88%) claimed that they will continue using 1001 story in future educational activities.

5. Conclusions

1001Stories is a successful example of “instant multimedia”, a lightweight approach to multimedia development which pushes ultra simplicity, speed and low cost as the key driver of the development effort, still ensuring a good quality final application delivered.

The experience of using and evaluating 1001stories toolkit has shown that, by means of simplicity, low cost and short time for product creation, we can achieve a significant degree of acceptability and usage of our “academic” products, and in particular we can foster their adoption in schools – an environment that, at least in Italy, is reluctant to adopt ICT and new educational paradigms.

In particular, the Policultura project has shown that the overall approach implemented in the 1001stories toolkit is very effective in promoting “active” learning (Crocker, 2005)

of narrative and communication skills for young users and to expose them to ICT technology in a playful way. Finally, the experience of 1001stories has also proved its effectiveness in promoting collaborative learning (Benford et al., 2000; Werger, 1999), as it was demonstrated by the "social" mode in which the hyperstory-telling activities have been carried on at schools.

Further improvements to the 1001Stories toolkit are in progress and a wider community of professionals in various industries and educational institutions is increasingly interested in adopting the framework.

6. References

Antle, A. (2003). Case Study: The Design of CB4Kids' Story Builder. In *Proceedings of 2003 Conference on Interaction Design and Children*. UK : Preston.

Benford, S., Bederson, B.B., Åkesson, K.P., Bayon, V., Druin, A., Hansson, P., Hourcade, J.P., Ingram, R., Neale, H., O'Malley. C., Simsarian, K.T., Stanton, D., Sundblad, Y., & Taxén, G. (2000). Designing Storytelling Technologies to Encourage Collaboration Between Young Children. In *Proceedings of CHI 2000*. The Hague, Amsterdam: ACM Press.

Bloom, B.S., Mesia, B.B., & Krathwohl, D.R. (1964). *Taxonomy of Educational Objectives*. New York: David McKay.

Bruner, J. (2002). *Making Stories: Law, Literature, Life*. New York: Farrar, Straus and Giroux.

Ceri, S., Florian, D., Matera, M., & Facca, F. (2007). Model-driven Development of Context-Aware Web Applications. To appear on *ACM Transactions on Internet Technology, 7* (2), 1-32.

Crawford, C. (2004). *Chris Crawford on Interactive Storytelling*. New York, USA: New Riders.

Crocker, J. (2005). Active Learning Systems. *ACM Computers in Entertainment, 3* (1), 57-68.

Czarniawska, B. (2004). *Narratives in Social Science Research*. London: Sage.

Di Blas, N., Bolchini, D., & Paolini, P. (2007). "Instant Multimedia": A New Challenge For Cultural Heritage. In J. Trant & D. Bearman (Eds), *Proceedings of Museums and the Web 2007*. Retrieved October 13, 2007, from: http://www.archimuse.com/mw2007/papers/diBlas/diBlas.html.

Fayad, M.E. (2000). Introduction to the computing surveys' electronic symposium on object-oriented application frameworks. *ACM Computing Surveys, 32* (1), 1-9.

Garzotto, F., & Megale, L. (2005). Towards Enterprise Frameworks for Networked Hypermedia: a Case-Study in Cultural Tourism. In *Proc. ACM Hypertext'05*, 257-266.

Garzotto, F., & Megale, L. (2006). CHEF: a User Centered Perspective for Cultural Heritage Enterprise Frameworks. In *Proc. Conference AVI'06,* 293-301.

Garzotto, F., Paolini, P., Bolchini, D., & Valenti, S. (1999). "Modeling by patterns" of Web Applications. In *Proc. International workshop on the World-Wide Web and Conceptual Modelling* , WWWCM'99, 293-306.

Glassner, A. (2004). *Interactive Storytelling: Techniques for 21st Century Fiction*. Natick (MA), USA: A. K. Peters.

Joyce, M. (1997). *Afternoon - a story*. Cambridge, MA: Eastgate.

Mallowy, J., & Marshall, C.C. (1996). *Forward Anywhere*. Cambridge, MA: Eastgate.

Meyrowitz, N. (1986). Intermedia: The architecture and construction of an object-oriented hypermedia system and applications framework. *In Proc. ACM OOPSALA'86*, 186-201.

Mori, G, Paternò, F., & Santoro, C. (2004). Design and Development of Multidevice User Interface through Multiple Logical Descriptions. *IEEE Trans. On Software Engineering, 30* (8), 507-520.

Pachyderm - http://www.pachiderm.org/

Schwabe, D., Rossi, G., Emeraldo, L., & Lyardet, F. (1999). Web Design Frameworks: An approach to improve reuse in Web Applications. In *Proc. WWW99 Web Engineering Workshop*. Paris, France: Springer.

Storyspace. http://www.eastgate.com/Storyspace.html

Sutcliffe, A.G., & Mehandjiev, N. (2004). End User Development. *Communication of the ACM, 47* (49), 33-37.

WebRatio - http://www.webratio.com

Werger, E. (1999). Communities of Practice, Learning, Meaning, and Identity. Cambridge, UK: University Cambridge Press.

7. ANNEX

POLICULTURA Evaluation Questionnaire

1. How do you agree on the following statements about the learning benefits of Policultura?

- *Deeply understanding the topic*
- *Catch the links and relationships between topics*
- *Memorize longer what has been learned*
- *Raising interest in the topic*
- *Being involved in the class work*
- *Get or refine technical skills*
- *Get or refine communication skills*
- *Get or refine team work skills*

SCALE:
(-2) Much less than usual class activity
(-1) Less than usual class activity
(+1) More than usual class activity
(+2) Much more than usual class activity

2. Provide any comments concerning the learning benefits of Policultura

3. How good do you consider Policultura as a mean to promote that alliance between culture, technology and new learning paradigm that is so much wished for in the Italian school system?

SCALE:
(-2) Not effective at all
(-1) Not very effective
(+1) Quite effective
(+2) Very effective

4. Briefly describe how you have organized the class activity during Policultura.

5. Are you willing to use the toolkit offered by Policultura in further educational initiatives?
YES – NO

6. If yes, how would you imagine to use it?

7. Overall, how do you value the impact on the teaching activity?

SCALE:

(-2) Negative

(-1) Low

(+1) Discrete

(+2) Very good

If you would like to receive the full results of the evaluation questionnaire of Policultura, please contact Franca Garzotto, at garzotto@elet.polimi.it

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On Line Collaboration for Building a Teacher Professional Identity

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ABSTRACT

In this paper it is our intention to discuss a Teacher Education proposal that uses an on line asynchronous learning environment to develop collaborative practices and to enhance a professional identity. Using an integrated multi-method approach for analysing the on line discussions of 47 teacher students, a research group of the University of Padua[*] has explored: a) how different groups of student-teachers build and modify their professional profile pre-post a *case-work* on line activity; b) the nature of the interactive processes activated during *case-work* on line activity; c) the styles of *case* solutions. The findings show that the collaborative learning context supported pre-service and in-service groups of students differently in their professional development and in professional identity changes. Some implications for future research on teacher education are discussed.

Keywords: *e-learning, teacher education, professional identity, collaboration, case-based pedagogy.*

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1. Theoretical Framework

In the academic year 2005-06 a research group of the Educational Sciences faculty in Padua set up a Teacher Education project that had the aim of offering trainees an on line asynchronous environment for "reflective experience": in an on line laboratory the students could develop their own professional identity through collaboration, research, and discussion. Electronic discussion boards provided an interactive venue where teachers and future teachers could reflect, evaluate, solve problems, or exchange ideas (Pawan, Paulus, Yalcin, & Chang, 2003).

In designing the project we considered the following three points.

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1. *Currently Professional Identity is receiving increasing attention in the field of teacher educatio*n

In the 1980's the issue of teacher beliefs has begun to draw increasing attention. In reality these beliefs, held regarding learning and teaching, seemed to strongly determine their actions. Many people asserted that the greatest part of knowledge provided during professional preparation was nullified and replaced by the whole of experiences, role models, needs, routines that constituted the beliefs of teachers. Moreover, today we see a accent shift within these studies. Initially it was considered important to find out how teachers thought about education. Today more attention is being paid to the beliefs people have about themselves, to how one sees his/her role as a teacher (*professional identity*).

Korthagen (2004; Korthagen & Verkuyl, 2007) considers the professional identity as a central dimension in search of the essence of the "good teacher". In his "onion model", he defines six levels to define the essential qualities of a good teacher: the outer levels (*environment* and *behaviour*) are easily changeable; the central levels (*teacher identity* and *mission)* are more linked to the self and are extremely resistant to change. Because until today, teachers educators have paid too little attention to the inner levels of the model, the author emphasizes the need of educational projects to aim at these levels.

Janet Alsup (2005) thinks that forming a professional identity is a central process of becoming an effective teacher. Preservice teachers need a teacher education that provides them with opportunities to develop a satisfactory professional identity: they have to take care of themselves first, in order to better take care of others later. For this, teacher educators «must bring issues of identity into the methods class […and…] «must talk to pre-service teachers about the difficulty of professional identity development» (Alsup, 2005, p. 7).

John Loughran (2007) explain that «students of teaching need opportunities to learn, un-learn in order to better know themselves so that they might better understand how and why they teach in the way they teach; especially if they seek to change» (p. 112). To know how one's self image and professional identity have been shaped and influenced by beliefs helps prospective teachers to have more awareness of their actions and to address their professional development in a personal manner.

Watson (2006), like Connelly and Clandinin (1999) before, emphasizes the character narrative of identity and suggests that «Identity is an ongoing and performative process

in which individuals draw on diverse resources to construct selves. This process is seen as emerging in and through narratives of practice» (Watson, 2006, p.509).

In this light we think that it is important to offer educational contexts where the participants challenge themselves, describe themselves as future teachers, reconsider their beliefs, elaborate professional consciousness; and thus work on their professional identity.

2. *A key aspect of teacher's culture today is collaboration*

Woods, Jeffrey, Troman and Boyle (1997) assert that the *culture of individualism* of old school's order impedes innovation. They see the *collaborative management* of schools, the shared decision making and conversation, as the main way for restructuring schools in order to improve educational systems. They also define teachers as *collaborative professionals*; indeed collaboration is the central element in new professionalism and a requirement of the work of teaching.

In a Vygotskian perspective, Joanne Deppeler (2007) views collaboration as a central factor for professional development: teachers, like all learners, learn through collaborating with others, in articulating and sharing ideas, in creating solutions to the challenges situated within their context; so professional learning is a process of *collaborative inquiry* that determines the transformation of practices and the construction of new professional knowledge.

In our project the students had opportunities to engage themselves in collaborative inquiry as the process of reflection through which a group of peers strive to answer a question of importance to them. The laboratory activities were marked by valuing both individuality and interdependence, by awareness of belonging to a group and a collective sense of responsibility.

3. *The potentiality of a case based pedagogy in Teacher Education*

In stressing the necessary integration of theory and practice in teacher education, Miriam Ben-Peretz and Irit Kupferberg (2007), following Shulman's thinking, claim that «learning from cases is one way of effectively integrating learning with practice. Case-based learning experiences provide vicarious encounters with practice that can be negotiated by discourse communities of pre- and in-service practitioners» (Ben-Peretz & Kupferberg, 2007, p. 127). Case-based education seems to support a disposition to reflect on various elements of practice.

In effect since the early 1980s, Shulman pay much attention to case-based methods for professional development of teachers. He thinks that cases can play a critical role in learning from experience: «A case resides in the territory between theory and practice,

between idea and experience, between normative ideal and achievable real» (Shulman, 1998; 2004bp. 543).

In asserting that *a narrative is the case* he explains that when teacher-educator and students explore the question "what is this a case of?", they move in two directions simultaneously: «They connect this narrative to their remembered (personal) experiences or to vicariously experienced cases written or recounted by others, thus relating this particular case to other specific cases. They also connect this narrative to categories of experience, to theoretical classification through which they organize and make sense of their world» (Shulman, 1996; 2004a, p. 474). Working on cases involves the same principles that characterize the conditions for effective substantive and enduring learning in the communities of learners (Brown & Campione, 1994): learners are active agents in the process of learning, they can reflectively turn around on their own thought and action and analyse how and why their thinking achieved certain ends or failed to achieve others; they are engaged in collaboration and scaffolded by the community and by the community culture. When new or veteran teachers work in a case, they are actively engaged in their own understanding; they are stimulated to reflect by the act of re-cognition of turning around on one's own lived experience and examining them; moreover the thought process of cases is dialogic and cases become educative for teachers within teaching communities. From reading the cases of others analytically, drafting one's cases, commenting on one another's cases, relating stories to one another, the principles or theories emerge.

Further more, in suggesting that the heart of teaching is developing the capacity to respond to the unpredictable, the author asserts that «cases – as the narrative manifestations of chance – offer teachers the opportunities to contemplate the variety of ways in which the unpredictable happens» (Shulman, 1996; 2004a, p. 480).

Helen Harrington believes that "dilemma-based cases is intended to provide students of teaching with opportunities to recognize specific events as problematic; gain an understanding of them; reflect on them and on consequences of action; and devise sensible moral, and educative ways of acting. In doing so, dilemma case based cases provide insight into multiple aspects of critical reflection» (Harrington, Quinn-Learning, & Hodson, 1996, p. 26). Reflection on dilemma-based cases would help students to think about the consequences of their actions in wider settings, because these activities stimulate them to focus not only on the consequences of that particular case, but also on the social, political and cultural ones. *Case-based* pedagogy would stimulate the students to develop critical and complex thinking. What is more, case-

based discussion would represent the favorable setting for developing *reciprocal teaching* and peer support, and building depth of thought. In other words, case-based discussion would promote experiences that generate cognitive dissonance and would stimulate shifts in personal perspectives (ibid.).

In this light the programs of teacher courses should be organized in *study teams* and focalized on the development of «conceptual understanding of teaching, peer learning and debate or exchange, studying and working out authentic teaching problems and cases» (Tillema,1997, p. 292).

Shihkuan Hsu (2004) highlights the educational potentiality of on line case-work. She argues that student teachers became aware of their assumptions, considered multiple perspectives, developed understandings of problems and obtained knowledge and skills to deal with them while discussing their own problem cases in the so called *CaseForum*. In a few words, they gained positive attitudes towards the teaching profession. CaseForum seemed to be a positive support for opening to scrutiny the cases and for enhancing discussions on the problems encountered during teaching practice

2. Aims

The research has two aims.

The first aim is to correlate the different constructions of professional profiles in pre-service and in service teacher students, pre-post case-work activities.

The second aim is to analyse the nature of interactions among future teachers and in-service teachers, specifically social cognitive processes within shared case-work on-line discussion.

3. Methodology

3.1. Participants and Task

56 second-year female students had initially enrolled in the laboratory, 47 actively participated in all the phases of the course. 18 subjects were workers (novice and experts in-service teachers with from 1 to 3 years of work experience, respectively, or more), 29 are students (pre-service teachers) between 20-22 years old.

All the activities were on-line; the students interacted among them in an asynchronous web site especially created. The on-line course started in April and finished in July and had 5 modules. It started with a 10-day phase of familiarization with the on-line environment followed by 4 modules dedicated to knowledge sharing and reflection on working practices. The activities provided participants with opportunities to engage themselves in two roles: as sources of problem cases and as problem-solvers, at their own pace and with no time pressure. Students were required to work individually or in groups of five or six subjects. The 8 groups were:

- 1 group in-service of expert teachers (*n 6*) (INSE)
- 1 group in-service of novice teachers (*n 6*) (INSN)
- 1 group of educators (*n 6*) (EDU)
- 5 groups of students (*n 29*) (STU)

The numbers of subjects in the groups reflected in percentages the proportion of students that attended the courses for teacher preparation.

The types of activities were the following:

1. The students individually wrote two profiles of “what it means to be a good teacher”: the first before the case-work, the second at the end of the activities;
2. Remembering their scholastic experiences, the subjects shared and constructed, one problematic real life case in on-line forum;
3. They discussed and justified different solutions in forum, and wrote a shared text which was a synthesis of these by means of a collaborative writing tool.

3.2. Data Collection and Analysis

Data was collected in an asynchronous multi-participant context of discussion in which the student teachers interacted with each other without the intervention of the on line-tutor.

The data comprised of:

- all the writings that students individually wrote to define the “good teacher” pre-post interactive forum;
- the sequences of messages in the forum of three different groups (INSE, INSN, STU); each sequence comprised the messages of the dialogical interactions for the choice or co-construction of real life cases to confront and discuss;
- the writing of case synthesis of three groups (INSE, INSN, STU)

We compared the *pre-post* profiles, through T-Lab, a software consisting of a set of linguistic and statistical tools which help to extract, compare and map the contents of texts. We applied the specificity analysis and the correspondence analysis to the texts.

We analysed the forum with Garrison and Anderson (2003) content analysis categories: *social presence*, *teaching presence*, *cognitive presence*. In this framework, these *presences* are the core elements that reflect meaningful learning activities essential in an e-learning environment and, at the same time, they constitute a tool to value the nature and quality of an e-learning experience.

Two researchers simultaneously coded the *social*, *cognitive* and *teaching* speech segments in the same sequences of messages; inter-rater reliability was 86%. In accepting the Garrison, Cleveland-Innes, Koole and Kappelman (2006) methodological suggestions, the unit for content analysis was the message. In the study, data was analyzed qualitatively. Analyses were undertaken by means of descriptive statistics, content analysis.

The written case synthesis were examined through Harrington's coding system (1996) to determine if aspects of critical reflection – *open-mindedness, responsibility, wholeheartedness* - could be identified in students' work. The critical interpretive analysis was refined through multiple passes of the students' written case analyses, by two researchers who discussed and negotiated a common interpretation. At the first level the researchers analysed the statements that account for the different students' teachers perspectives (*teacher-focused*, *child-focused*, *inclusive*). At a second level the texts were examined for statements that provided information on the limitedness or inclusiveness with which the participants recognized consequences of action (*for students only, for teacher and students, for teacher, students, others and broader social consequences*). The third level of coding provided information regarding taken for granted and awareness and non- awareness, students' assumptions about teaching. Finally, in the light of the previous levels of analysis, the researchers identified each text with the patterns of *wholeheartedness* (*teacher directed learning, education as an interactive process, education as a complex and interactive process*) to by which style pre- and in-service teacher of each group assume their professional role.

4. Findings

Pre-post text analyses have shown relevant changes in teacher profile elaborations. At the end of the laboratory, the students elaborated a more articulate and multi-dimensional profile than at the beginning of the activities.

In the initial profiles the "typical" lexical units, defined by means of the chi-square test computation (specificity analysis) are closer to personal attitudes and feelings, instead of professional competences and knowledge. We found statistical significance to words *love*, *transmission*, *sweetness* (df = 1; p. 0.001), *patience*, *passion*, *sensitivity* (df = 1; p. 0.01).

The final descriptions became more detailed, there were more qualities listed and the writings cited specific profession-related skills and means as *reflection*, *professional ethics*, *open-mindedness* (df = 1; p. 0.01), *assessment-evaluation, technologies* (df = 1; p. 0.05). An idea about the school as a community emerged from their writings, a community where teachers are able to interact not only with their students but also with colleagues, families and the like. The ability to work in a team - "*group*" is the lexical unit more frequent (df = 1; p. 0.001) - and to collaborate with the families was often underlined in students' final profiles.

Less significant are the *pre-post* changes in students in service-teachers; yet in their initial profiles we noted some common traits of teacher's expertise, (experts' characteristic strengths and weaknesses such as functional rigidity), corroborated in final profiles.

The correspondence analysis on the same corpus of texts corroborate these findings., In the scatter chart where we can see the relationship between typical lemmas used in the profile descriptions and variables (INSE, EDU, STU, INSN) we see that, at the start of activities, the novice teachers and students are near the cross axes (meaning a light professional identity) while expert teachers and educators have well-defined positions showing their professional imprinting (see Figure 1).

Moreover we noted that, between the pre- and post-forum activities (see Figure 2) - the expert teachers (INSE) do not change their position very much, whereas students (STU) and novice teachers (INSN) take a more defined position in the graph.

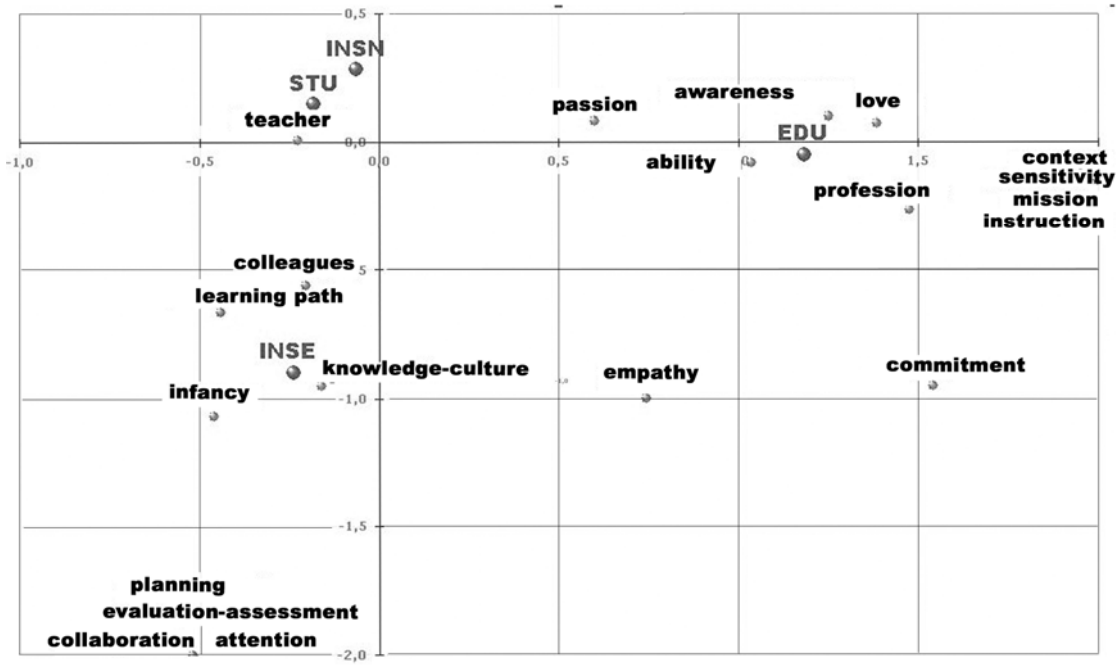

Figure 1. Correspondence Analysis at the Start of Activities.
Relationship between Typical Lemmas and Variables

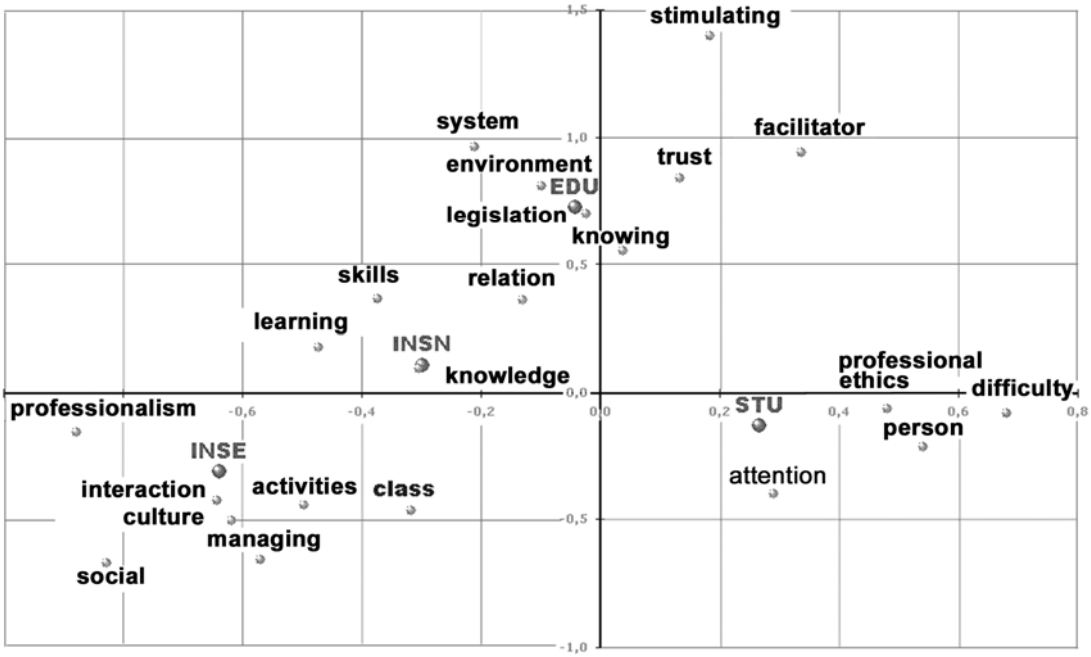

Figure 2. Correspondence Analysis at the End of Activities.
Relationship between Typical Lemmas and Variables

The second level of analysis of this study was the content analysis of the forum dialogical processes. We analysed the frequencies of the Garrison and Anderson

categories in the messages of 3 groups (INSE, STU, INSN) and the *density* figures for each discussion (Rourke, Anderson, Garrison, & Archer, 2001).

In general we can see that all the groups of students engaged in a high level of social activity (45.8% INSE, 44.7% STU and 38.1% INSN), higher than teaching activity 33.3% INSE, 36.2% STU, 33.6% INSN) and cognitive activity (20.8% INSE, 19.1% STU, 28.3% INSN). In effect Garrison and Anderson (2003) acknowledge the importance of social element in CMC discussion; they argue that «social presence is an important antecedent to collaboration and critical discourse» because «it means creating a climate that supports and encourages probing questions, skepticism and the contribution of more explanatory ideas » Garrison and Anderson (2003, p. 50).

In examining the findings of the 3 groups in more detail, the content analysis of on-line discussions have shown:

1. a dialogical co-constructive model of discussing in teacher-students *vs* a “strategic individualism” in in-service teachers;
2. a rooted professional identity in teacher-students unable to modify themselves because their professional identity is extremely embedded;
3. the emergence of a professional identity in students correlated with flexible, personal and social identities.

The analysis of writing case works with Harrington et al. (1996) model demonstrates that the students and the teachers solve their cases through different styles. The students’ writings are student-centred but the students elaborate their problems with reference to authoritative and theoretical sources, and show they are able to elaborate their emergent professional identity. The teachers’ perspective is more holistic, but the in-service teachers' analyses, as well as the solutions, are strictly based on experience and practical knowledge with no attempt to link the issue to theoretical concepts. Their digital messages show that the student teachers’ discursive explorations lacked theoretical considerations and are grounded in the local professional environments.

5. Conclusion

Inspired by the literature of teacher education and distance education, this study explored the shared construction of professional identity and the nature of interactions among student teachers in a cyberforum that focused on professional cases drawn from the participants’ professional or student’s life. The changes of awareness of

personal professional profiles pre-post case work in different groups of student teachers were identified. The nature of processes enabled by the case work was explored.

We have had some indications for pre- and in-service teacher education courses but the main problem that we think emerged from this study are the different behaviours in pre- service and in-service teachers, in view of the different formative proposals (forum, case work).

We think that there is a strong need to explore this point (e.g. the in-service teachers rigidity facing the educational proposals) in relation to in-service teacher education, particularly in the light of present Italian school politics that place particular attention of in-service teachers lifelong learning.

Our research corroborated the findings of Ben-Peretz and Kupferberg (2007). The expert teachers lack theoretical reasoning in the forum. We agree with the authors that in teacher education contexts, we need to provide a space for supporting these students to reflect more about and to create possible links between theory and practice. In this way their experiences can become professional knowledge.

Another point vital to reflect on, in relation to in-service teacher education, is that in our research the expert teachers seem to assume the *inflexibility* and the *functional fixedness* that Michelene T. H. Chi (2006) refers to as being some limitations of experts (*vs* novice).

In this light, inside of our work in progress study, we are now introducing different variables in the educational context. We would like to explore if the on line tutor's specific intervention in the forum or the heterogeneous groups can contribute to modify some of the in-service teacher's characteristics that the more knowledgeable participants can exhibit in a problem-solving context.

Following Bobbie Turniansky and Dina Friling, when they assert that «openness to learning with and from others is possible only if our own expertise is not allowed to take center stage» (Turniansky & Friling, 2006, p. 781), we can suppose that our teacher students were too much linked to our expert condition to effectively "put themselves in the game". The authors affirm that the *novice state of mind* is critical to the learning process of group as well as of individual: «It allows for true dialogue based on the premise that there is always room for what I can learn from others and with others. The novice state of mind, trust, sharing, individual and group learning - all these are critical components of true professional development» (p.783) and enable real changes.

In their contribution they focus on the necessary conditions for encouraging the expert to approach each situation with the fresh eyes of the novice: he has to feel individual confidence in the group and trust in others to open himself, his views, values, understandings, knowledge to examination and re-evaluation.

In this light we think that we have to pay particular attention on foster students, to familiarise each other and to get confidence in the group, before the starting of and during the educational activities with experts.

There are other future perspectives to this study.

Some limitations stems from our analysis of discussion transcripts over a short period of time. We included only 4 weeks of discussions to understand collaborative interactions: less time to verify the changes in personal depth dimensions such as professional identity.

Future research could include information gathered for a longer period of time and from additional sources such as interviews with students and instructors to provide insight into additional factors responsible for collaborative interactions, or the lack of them in discussions.

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7. References

Alsup, J. (2005). *Teacher Identity Discourses. Negotiating Personal and Professional Spaces*. Mahwah, N. J.: Lawrence Erlbaum Associates.

Ben-Peretz, M., & Kupferberg, I. (2007). Does teachers' negotiation of personal cases in an interactive cyber forum contribute to their professional learning? *Teachers and Teaching*, *13*(2), 125-143.

Berry, A., Clemans, A., & Kostogriz, A. (2007). *Dimensions of professional learning. Professionalism, Practice and Identity*. Rotterdam, The Netherlands: Sense Publishers.

Brown, A. L., & Campione, J. C. (1994). Guided discovery in a Community of learners. In K. McGilly (Ed.), *Classrom Lesson: Integrating Cognitive Theory and Classrom Practice* (pp. 229-270). Cambridge: MIT Press.

Chi, M. T. H. (2006). Two Approaches to the Study of Expert's characteristics. In K.A. Erikson, N. Charness, P.J. Feltovich, & R. R. Hoffman (Eds.) *The Cambridge Handbook of Expertise and Expert Performance* (pp.21-30). Cambridge: Cambridge University Press.

Connelly, F. M., & Clandinin, D. J. (1999). *Shaping a professional identity: Stories of education practice*. London, ON: Althouse Press.

Depler, J. (2007). Collaborative inquiry for professional learning. In A. Berry, A. Clemans, & A. Kostogriz (Eds.), *Dimensions of professional learning. Professionalism, Practice and Identity* (pp.73-88). Rotterdam, The Netherlands: Sense Publishers.

Garrison, D.R., & Anderson, T. (2003). *E-Learning in the 21 Century. A Framework for Research and Practice.* London and New York: Routledge Falmer.

Garrison, D. R., Cleveland-Innes, M., Koole, M., & Kappelman, J. (2006). Revisiting methodological issues in transcript analysis: Negotiated coding and reliability. *Internet and Higher Education, 9,* 1-8.

Harrington, H., Quinn-Learning, K., & Hodson, L. (1996). Written case analyses and critical reflection. *Teaching and Teacher Education, 12*(1), 25-37.

Hsu, S.(2004). Using case discussion on the web to develop student teacher problem solving skills. *Teaching and Teacher Education, 20*, 681-692.

Korthagen, F. A. (2004). In search of the essence of a good teacher: towards a more holistic approach in teacher education. *Teaching and Teacher education, 20*, 77-97.

Korthagen, F., & Verkuyl, H. S. (2007). Do you encounter your students or yourself? The search for inspiration as an essential component of teacher education. In T., Russel & J., Loughran (Eds.), *Enacting a Pedagogy of Teacher Education. Values*, *relationships and practices* (pp.106-123). London: Routledge.

Loughran, J. (2007). *Developing a Pedagogy of Teacher Education. Understanding teaching and learning about teaching*. London: Routledge.

Pawan, F., Paulus, T. M., Yalcin, S., & Chang, C.F. (2003). Online learning: patterns of engagement and interaction among in-service teachers. *Language Learning & Technology*, *7* (3), 119-140.

Rourke, L., Anderson, T., Garrison, D.R., & Archer, W. (2001). Assessing Social Presence in Asynchronous Text-based Computer Conferencing. *Journal of*

Distance Education. Retrieved October 19, 2006, from http://cade.athabascau.ca/vol14.2/rourke_et_al.html

Shulman, L. S. (2004a).“Just in Case: Reflections on Learning from Experience”. The Case for Education: Contemporary Approaches for Using Case Methods. In J. A., Colbert, P., Desherg, K., Trimble (Eds.) (1996) (pp. 197-217). Boston: Allyn and Bacon. Reprinted In S. M. Wilson (Ed.), *The Wisdom of Practice. Essays on Teaching, learning, and Learning to Teach* (pp. 463-484). San Francisco: Jossey-Bass.

Shulman, L. S. (2004b). Theory, practice, and the Education of Professionals. The Elementary School Journal, 98(5), 511-526. In J. A., Colbert, P., Desherg, K., Trimble (Eds.) (1996), (pp. 197-217). Boston: Allyn and Bacon. Reprinted in S. M. Wilson (Ed.), *The Wisdom of Practice*. *Essays on Teaching, learning, and Learning to Teach* (pp. 521-544). San Francisco: Jossey-Bass.

Tillema, H.H. (1997). Reflective Dialogue in Teams: a vehicle to support belief change in student teachers. *European Journal of Teacher Education*, *20*(3), 283-294.

Turniansky, B., & Friling, D.(2006). The Expert Novice. *Proceedings of the 7th International Conference on Learning Sciences ICLS* (pp. 778-784). International Society of the Learning Sciences,.

Watson, C. (2006). Narratives of practice and the construction of identity in teaching. *Teachers and Teaching: theory and practice*, *12*(5), 509–526.

Woods, P., Jeffrey, B., Troman, G., & Boyle, M. (1997).*Restructuring Schools, Reconstructing Teachers.* Buckingham: Open University Press.

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Risk Management Persuasive Technologies: The case of a Technologically Advanced, High-Risk Chemical Plant

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ABSTRACT

Our study focuses on applications of persuasive technologies (Fogg, 2002) as a means to manage risks in technologically advanced industrial sites. An analysis of the production processes of a chemical plant allowed us to identify two risk scenarios where human factors are particularly relevant: in chemicals identification and in the use of personal protective equipment. Possible solutions based on persuasive technologies and aimed at minimizing the occurrence of human errors were prototyped. Qualitative evaluation of the proposed solutions, which involved 7 potential users, both operators and safety engineers (the population consisting of 29 people), allowed us to have a first confirmation of their acceptability and persuasion effectiveness.

Keywords: *Persuasive technologies, risk management, automation, chemical plant, tunneling, reduction, simulation, cause-and-effect relationship, chemicals, personal protective equipment (PPE).*

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1. Introduction

The occurrence of accidents and incidents represents an intrinsic feature of any industrial activity. As far as technologically advanced industrial sites (like nuclear or chemical plants) are concerned, it has been pointed out that crises are often attributed to human error at present (Catino, 2002; Reason, 1990).

The extensive use of automation has led to considerable changes in the role of human operators, who tend to act mainly as supervisors of procedures carried out by

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machines, rarely performing physical tasks (Cacciabue, 2004). Thanks to automation, modern plants are certainly easier to operate; nevertheless, critical misunderstandings can occur between human and system, because of an inappropriate level of situation awareness or because of unsuitable behaviors induced by automation itself (Bainbridge, 1987). Moreover, the increasing reliability of hardware, which has minimized mechanical faults, emphasizes the contribution of human factors to accident genesis (Cacciabue, 2000; Cacciabue 2004).

In such scenarios, risk management necessarily implies that human fallibility is carefully dealt with in order to avoid negative effects on health, safety and environment. In particular, human behavior should be somehow modeled so that it is as safe as possible and potentially dangerous faults are prevented.

Since operators in highly automated industrial plants mainly interact with machines, it has been hypothesized that persuasive technologies can positively contribute to accident management, promoting correct behavior. According to Fogg, persuasive technologies can be defined as any type of computing system, device, or application that was designed to change users' attitudes or behaviors in a predetermined way (Fogg, 2002).

In particular, the introduction of microsuasion elements[1] in technologies ordinarily used to carry out industrial processes could stimulate operators to follow safe procedures and rules, thus minimizing the occurrence of errors and inappropriate behaviors.

At the same time, it has been assumed that technologies with an overall intent to persuade, such as simulators, could be expressly designed in order to improve operators' awareness of risks. These technologies could be effectively utilized in education and training courses.

2. Project Overview

This paper describes a study conducted in 2006 and aimed at testing our hypothesis, according to which persuasive technologies can contribute to make operators' behaviors' safer, thus proving effective in risk management.

[1] As defined in (Fogg, 2002), *microsuasion* elements are small persuasive elements incorporated in a technology which has an overall goal other than persuasion, in order to increase its effectiveness.

Our study focused on a highly automated chemical plant in the Piedmont region (Italy), which belongs to a well-known international group. It produces polyurethane systems containing MDI (*Methylene diphenyl diisocyanate*) and makes use of several chemical substances that can have damaging effects both on the environment and on human health, in case an accident occurs.

The project consisted of three phases: (1) *preliminary analysis*, aimed at identifying concrete risk scenarios where persuasive technologies may be applied; (2) *prototyping* of human-machine interfaces based on persuasive technologies; (3) *qualitative evaluation* of the proposed solutions.

3. Preliminary Analysis

The main goal of preliminary analysis was to understand whether there existed concrete scenarios where persuasive technologies may be applied in order to improve risk management. Therefore, we tried both to gain an overall understanding of production processes management and to identify specific risk scenarios. At the same time, risk management solutions already adopted in the plant were taken into consideration and compared with persuasive technologies potentialities.

3.1. Production Processes Management

Valuable information was obtained both by simply observing the operators at work, and by conducting a few semi-structured interviews with some of them. Most tasks are carried out automatically by a Production Processes Management System (PPMS), while operators have to check the list of simple actions (called “steps”) that are going to be performed in order to obtain a certain material and to start the procedure. After that, operators mainly act as supervisors and are sometimes asked to give their explicit consent for some steps to be performed. Nevertheless, some chemicals require manual loading. In order to accomplish this task, operators have to leave the control room, go and find the needed material in a warehouse, type the chemical identifying-code in a computer linked up to the reactor in use and (if the code is correct) manually load the reactor itself.

3.2. Risk Scenarios

Risk scenarios were identified both by interviewing the operators and by analyzing the incident register of the plant.

Whereas operators are forced to follow a standard, step-by-step procedure when they act as supervisors, manual operations like chemicals loading are affected by individual variability and thus appear more error-prone. Two main risk scenarios were recognized:

- *Chemicals Identification*

  Chemicals can be distinguished by an identifying code, which is written on two different labels[2] on the container and which has to be typed in before loading. Unfortunately, when the code is automatically checked by a computer, there is no way to discover whether: (1) the code has actually been read on the container; (2) both labels have been read. Operators admit rarely reading labels, as these are written in small, scarcely visible fonts. Moreover, skilled operators know most codes by heart, so that label-reading seems a waste of time.

  One of the most relevant incidents which actually took place in the plant was caused by loading a wrong chemical. The involved operators did not read the two labels on the container and missed noticing that they displayed different codes, because of a labeling error. As they typed in the required code by heart, the computer did not detect anything wrong and allowed to load a wrong chemical.

- *Use of Personal Protective Equipment (PPE)*

  Operators should wear PPE at work. However, protective long-sleeved shirts are not well accepted since temperatures are very high in the plant, especially in summer. Moreover, operators think it is very unlikely that they can come into contact with dangerous chemicals, because only a few steps are performed manually. Skilled operators also feel quite confident in themselves, so they prefer wearing comfortable T-shirts.

  Nevertheless, 11 out of 32 registered incidents involved contact with dangerous substances.

[2] One of the labels is stuck by the producer, the other one by an internal chemical laboratory.

3.3. Alternative Approaches to Risk Management

Since the international group to which this chemical plant belongs strongly emphasizes safety in its policies, several risk management techniques are already adopted, which can be considered typical of technologically advanced industrial sites.

On the one hand, an integrated system of sensors and alarms is used to monitor critical data and to alert the people in charge, in case unexpected or abnormal events occur.

On the other hand, reliable hardware is adopted, which can also perform automatic controls and prevent some potentially dangerous actions from being executed. Safety rules that define standard, correct procedures and regulate the use of PPE are established in order to model the operators' behavior. Safety rules and related issues are usually addressed in training courses for newly-employees and further discussed during periodic meetings with safety engineers. Traditional media such as posters are also used to provide safety-related information.

Useful though they are, these solutions do not appear sufficient to effectively manage human fallibility, as demonstrated by the accidents that still characterize manual steps, where the trade-off between safety and other relevant factors may negatively influence the performance of the operators.

As stated by (Reason, 1990), safety norms considered trivial (since risk is perceived as remote) are likely to be routinely violated. Unfortunately, formative meetings where operators are passively taught correct behaviors are not so effective as firsthand, interactive experiences (Fogg, 2002). Moreover, some of the operators we interviewed considered the information provided as biased, reflecting the safety engineers' point of view, as opposed to their own. Finally, posters and other traditional media lack interactivity (Fogg, 2002) and cannot guarantee that they are actually accessed.

Persuasive technologies have several advantages over the described risk management approaches (Fogg, 2002). By integrating persuasive elements into the technologies already in use, contextual help can be provided at the right time and place; moreover, technologies can be designed in order to be persistent and ubiquitous, so safety-related information is not limited to specific occasions, such as training courses. In comparison with human persuaders, technologies can not only store and access huge volumes of data, but also convey them using many modalities, in appealing and meaningful ways. Finally, persuasive technologies that provide simulations offer firsthand, interactive experiences and are more likely to be perceived as "objective" and "unbiased".

4. Prototyping

An analysis of the two described risk scenarios was conducted in order to identify which changes in the operators' behaviors and attitudes should be obtained, with the aim of improving safety and preventing incidents. In order to define an appropriate persuasion strategy, both the kind of tasks performed by human operators and the role played by technologies were taken into consideration. According to Fogg, in fact, computing technologies can play three basic roles –tool, medium and social actor[3]-, depending on which they can take advantage of different persuasion techniques (Fogg, 2002).

Prototypes consisted of a series of slides, which simulated a UI and suggested how users would interact with the system, thanks to some simple animations.

4.1. Prototype 1: Chemicals Identification

In order to avoid errors when operators manually load chemical substances, it should be guaranteed that:

- Identifying-codes are read on the labels, instead of being typed in by heart;
- Both labels are read;
- Reading and typing errors do not occur (although these errors are unlikely to cause an incident, they slow down production processes, since the computer will detect a wrong code and not allow loading until the correct one is provided).

We suggested that "traditional" labels should be replaced with bar codes and read automatically with a bar code reader activated by operators. Feedback for the interaction should be provided through a small display, the user interface of which was prototyped, simulating different cases (correct codes, wrong codes, internal and producer codes do not match, same label read twice). Once both labels have been automatically read, the computer checks the codes. It is important to notice that internal and external codes must be distinguishable[4], so that the computer can detect whether the same label has been read twice and not allow loading.

The proposed solution implements both tunneling and reduction strategies, which are suitable for a work tool (as defined in Fogg, 2002). Tunneling consists in guiding users

[3] Computing technologies mainly act as tools if they are conceived to increase users' capabilities; whereas media are intended to provide experiences by conveying symbolic and sensory information. Computing technologies are perceived as social actors if they are able to create social relationships with their users (Fogg, 2002).

[4] For example, we hypothesized using a prefix before the proper bar code on the internal label.

through a certain process or experience step by step; moreover, each step cannot be afforded before the previous one has been completed, thus creating a series of interlocks. Reduction technique implies that complex activities are simplified and reduced to a few simple steps, thus increasing their benefit/cost ratio.

As far as tunneling is concerned, the prototyped solution actually implies that operators are led through a standard procedure step-by-step: in fact, they are asked to read the first bar code, then the second one, then the computer automatically checks them. Moreover, the following step (actually loading the reactor) is only allowed if the previous procedure was completed properly – namely, if both labels were read and if the codes are correct.

The operators' task is also easier than before, as they only have to perform an automatic reading, using the bar code reader, instead of trying to read a scarcely visible code and typing it in manually (reduction).

We hypothesized the proposed solution should be persuasive (namely, it should help to obtain the desired changes, which we stated at the beginning of the paragraph) because:

- The operators' task is easier and quicker to perform;
- Reading and typing errors are avoided, so that the procedure is more efficient;
- Operators are compelled to follow a safe, standard procedure which guarantees that: (1) codes are read on the labels and not typed in by heart; (2) both labels are read.

4.2. Prototype 2: Use of Personal Protective Equipment

Since they are not fully aware of the risks they are taking, operators are not willing to wear uncomfortable protective long-sleeved shirts. In order to minimize incidents due to contact with dangerous substances, operators should be stimulated to change their attitude and wear their PPE, as stated by safety rules. Consequently, our goals are:

- Producing evidence in support of safety rules;
- Showing available information in an understandable and meaningful way;
- Enabling operators to observe the link between cause (wearing/not wearing their PPE) and effect (the risks they are taking);
- Stimulating a positive attitude toward safety rules;
- Preventing violations.

We suggested that interactive media technologies should be used to simulate cause-and-effect relationships, so that operators can better understand the risks they are taking and the likely consequences of their choices (whether to wear their PPM or not). Such technologies could be used in education and training courses, thus complementing the traditional top-down, "passive" learning.

Our prototype exemplifies the user interface of software that simulates the consequences of operators' behavior, based on an assessment of risk level in the different departments. Risk level was simply calculated as a ratio between incidents due to contact with dangerous substances and incidents of any kind, using the data provided by the chemical plant itself.

First, the user is asked to choose a department (a simulation is also available for the plant as a whole) and is told how many incidents have occurred there up to now. The operator is then asked to choose whether to wear a protective shirt or not. Finally, a simulation is run which shows the effects of his or her choice.

The proposed solution clearly aims at changing the operators' attitudes and behaviors by exploiting the so-called Principle of Cause and Effect (as stated in Fogg, 2002): in fact, operators are allowed to safely experiment with different kinds of behaviors and to immediately observe their consequences. This solution is expected to prove persuasive because:

- It provides data in a simple and understandable way; moreover, these data could be completely new to some operators;
- It shows the cause-and-effect relationship between the operators' behaviour and the risks they are likely to take;
- It allows the operators to have a firsthand, although simulated, experience;
- It offers an "objective" assessment of risk level;

Simulations are based on data about real incidents, which occurred in the plant and are thus personally relevant to operators.

5. Qualitative Evaluation

The prototypes were then examined by help of some potential users, in order to evaluate persuasion effectiveness and acceptability of the proposed solutions. We also welcomed any suggestions about user needs and comments about the persuasion goals we set.

Each session involved only one user at a time and began with a short introduction to the evaluation task. In order to guarantee uniform conditions, all instructions were provided by reading predefined scripts.

In particular, users were told they should interact with the prototypes and carefully observe the provided feedback; although they would be explicitly asked for comments later, they were encouraged to think aloud during the interaction. Users were also assured that neither their performance nor their opinions were going to be assessed and that data would be treated anonymously. Therefore, they were encouraged to express their evaluations freely.

Each session consisted of two main phases that lasted about ten minutes in all and were replicated for both prototypes.

During the first phase, users were asked to try to interact with the prototype after a brief description which also stated the persuasion goals of the prototype itself. As far as the first prototype is concerned, users were asked to simulate a manual loading operation –small boxes were provided to simulate a bar code reader and chemicals containers. The slides which simulated the interface of the display were showed by one of the authors according to users' actions. The second prototype was meant to be freely explored; however, users were asked to run at least two simulations. All comments expressed during this phase were recorded.

During the second phase, a semi-structured interview was conducted in order to better investigate users' opinions. More specifically, questions aimed at assessing the overall acceptability of the proposed solution, the relevance of the defined persuasion goals and the perceived effectiveness of the prototyped solution in achieving these goals (for example, users had to evaluate if prototype 1 was likely to minimize chemicals identification mistakes). Comments about potential pitfalls and critical scenarios were also welcome. Moreover, users may be asked to further elaborate on particularly interesting comments expressed during the previous phase.

Evaluation sessions involved a non-probabilistic sample of seven users, six skilled operators and one safety engineer (the population consisting of 29 people). Comments and suggestions were also provided via email by another safety engineer.

A qualitative content-analysis was then performed in order to distinguish between positive, negative, mixed and neutral evaluations. Specific expressions used to describe both users' reactions and the prototypes were identified, as well as any mention of perceived advantages and disadvantages.

5.1. Prototype 1: Evaluation

Comments about this prototype are very positive.

Users think that the proposed solution would make manual loading operations both quicker and safer. In fact, even if accurate code-checking is likely to take some time, automatic label-reading is fast and easy to perform (operators do not need to try to read scarcely visible labels); moreover, reading and typing errors are avoided, thus speeding up the operation. As far as safety is concerned, users agree that the proposed solution should be effective, because it guarantees that codes on the chemicals containers are checked. Consequently, errors in substances identification should be minimized.

This solution was well-accepted as it “empowers” users: in fact, it allows the operators to perform their tasks more easily and quickly; moreover, it does not require any additional effort. Persuasion goals were also approved, since they perfectly match users’ ones; furthermore, operators considered chemicals identification errors very relevant and they were looking forward to implementing a working solution.

5.2. Prototype 2: Evaluation

Users’ reaction to Prototype 2 is mixed. It is very interesting to note that both users’ role and personal beliefs about the particular safety rule that was considered (wearing protective long-sleeved shirts) seemed to influence the prototype evaluation.

In fact, we noticed that both safety engineers were quite enthusiastic about the proposed solution and thought that it could actually change operators’ attitudes, persuading them to wear their PPE. One of the interviewed engineers stated that such a simulation could prove very useful during training courses for newly-employed operators.

Most operators, on the contrary, had expressed a negative opinion about wearing protective shirts (before trying the prototype) and subsequently declared themselves to be very skeptical about the persuasive effectiveness of the proposed solution. In fact, these operators were very skilled and thought they already had an appropriate perception of risks (even if they admitted that the simulation provided data in a simple and meaningful way), so that they could make informed choices. Nevertheless, most of them were surprised by the data, and they all tried to run more than the two simulations we requested as a minimum. Moreover, some operators said they were “curious” and “very interested” in running the simulations, which were usually chosen based on personal criteria, rather than on mere chance. On the whole, even if the

expressed opinions were quite skeptical, the operators were very motivated and showed a positive attitude. Simple though they were, the provided simulations proved quite engaging.

Only one of the interviewed operators thought that wearing protective shirts was useful (before trying the prototype): he also expressed a very positive opinion about persuasion effectiveness of the proposed solution, stating that such a simulation could actually change the other operators' negative attitudes towards wearing their PPE.

6. Conclusion

Our study aimed at providing some insights into possible applications of persuasive technologies in the risk management domain.

The comments and suggestions we collected offer a first, qualitative evaluation of persuasive technologies acceptability and potential effectiveness. However, further experimental studies are needed in order to better understand in which ways –and to what degree- persuasive technologies can contribute to risk prevention and management in technologically advanced industrial sites. In particular, future studies are planned with the aim of addressing the following points:

- Users' opinions should be measured quantitatively, for example using 7-step ladders, in order to allow more accurate comparisons and statistical analysis;
- Larger, probabilistic samples should be defined as a prerequisite for significant findings;
- Actual persuasion effectiveness should be measured, instead of perceived persuasion effectiveness: for example, it is planned to measure and compare the operators' attitudes towards the use of PPE between two different groups, only one of which has interacted with the prototype. A more accurate assessment of risk level is expected among the operators who tried the simulator; a slightly more positive attitude towards the use of PPE is also quite likely. Experimental studies might also be planned aimed at observing behavioral changes – in this case, more sophisticated prototypes will be needed, in particular as far as chemicals identification is concerned.
- As far as prototype 2 is concerned, different modalities to convey data should be compared. Moreover, even if the simulation itself is engaging, it is important to define and test ways to guarantee that: (1) operators are

stimulated to try the simulation, in spite of their initial skepticism; (2) the simulation is still perceived as “objective” and “unbiased”, even if it is used during training courses.

Looking forward to future research in this area, it may be useful to emphasize some of the conclusions our present study allowed us to draw. We pointed out that:

- Persuasive technologies (used as tools) are likely to be effective if they do not overload their users with additional tasks; on the contrary, they should “empower” users and help them to achieve their goals simply and quickly;
- Persuasive technologies are more likely to be accepted if they serve their users’ goals, rather than any external goal; similarly, persuasive technologies can be welcome if they apply to a domain which is relevant to the user;
- Persuasive devices may be refused if they apply to domains about which users feel confident and skilled. In this case, persuasive devices may be perceived as a sort of “threat” to users’ freedom and expertise;
- Persuasive technologies such as simulations are generally quite appealing, so that even skeptical users are motivated to try them. Motivation, curiosity and openness are all prerequisites to the success of persuasion (Fogg, 2002; Petty & Cacioppo, 1981).

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8. References

Bainbridge, L. (1987). The ironies of automation. In Rasmussen, J., Duncan, K., & Leplat, J. (Eds)., *New Technology and Human Error* (pp. 276 -283). London: Wiley.

Cacciabue, P. C. (2000). Gestione dell’errore umano in sistemi ad alta automazione. In G. Mantovani (Ed.). *Ergonomia* (pp.81-121). Bologna: Il Mulino.

Cacciabue, P. C. (2004). *Guide to Applying Human Factors Methods. Human Error and Accident Management in Safety Critical Systems*. London: Springer.

Catino, M. (2002). *Da Chernobyl a Linate. Incidenti tecnologici o errori organizzativi?* Roma: Carrocci.

Fogg, B. J. (2002). *Persuasive Technology. Using computers to change what we think and do.* San Francisco: Morgan Kaufmann.

Reason, J. (1990). *Human error*. Cambridge: Cambridge University Press.

Petty, R. E., & Cacioppo, J.T. (1981). *Attitudes and Persuasion: Classic and Contemporary approaches.* Dubuque, IA: William C. Brown.

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Market Relations, Non-Market Relations and Free Software

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ABSTRACT

Free Software is sometimes considered solely a technical option, but that is a quite limited point of view: we suggest, indeed, that Free Software is not merely a technical option, but it is, in fact a different working paradigm for the software development community and a different model for acquiring (and sharing) resources in the Information Society. This paper will discuss this working paradigm and analyse the market and non-market relations that are implied by it.

Keywords: *free software, open source, business models, hacker ethics, software engineering*

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1. Introduction

Researchers from different backgrounds have been analysing market and non-market relations in different contexts: amongst Stone Age tribes (Sahlins, 1972), amongst the Trobriands in Melanesia (Malinowski, 1984) and in the modern industrial society (Lapavitsas, 2004), just to name a few examples. These researches, while different in many aspects, show how there has been and there still is a strong presence of non-market relations in different societies. This paper aims to show how a similar perspective can be seen in the Information Society context, discussing the role of the Free Software movement.

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The Free Software movement advocates the development and use of software that is free to use, free to modify and free to redistribute, on both pragmatic (Stallman, 2002) and philosophical (Stallman, 2004) grounds. The Free Software movement shares many points of contact with the Open Source movement (Perence, 1999), and they are often commonly referred together, as FLOSS (Free/Libre and Open Source Software) (FLOSS project 2002), FOSS (Free and Open Source Software) (Bollinger, 2003) or F/OSS (MIT Open Source Group, 2002).

In this paper we are referring to Free Software, but the discussion applies equally to Open Source, as the two terms are, in most cases, interchangeable.

Free Software is not necessarily gratuitous; freedom to use refers to the freedom to run for any purpose, not to price. In some cases, the user may have to pay a price to obtain the software: for example, Richard Stallman was charging 150 dollars for the first version of Emacs (Stallman, 1988).

Similarly, some software gives the user the freedom to use and redistribute the software, but not to change it and thus it does not qualify as Free Software. This is the case, for example, of freeware and shareware (Werbach & Dreben, 2003), that are merely royalty-free.

Noticeable examples of Free Software include the operating system Linux, the web server Apache and the office suite OpenOffice.org.

Research on Free Software has already examined in depth the business models that drive its development (Bonaccorsi & Rossi, 2003; Haruvy, Prasad, & Sethi, 2003; Hertel, Niedner, & Herrmann, 2003; Lakhani & Wolf, 2003; Lerner & Tirole, 2001; Lerner & Tirole, 2002). Some organizations base their business on selling services (e.g. IBM, Novell and Sun). For example, often companies sell Linux distributions, that are based on the customization and integration of existing Free Software. Other companies, such as MySQL AB, do business by selling proprietary versions of their Free Software, that can be integrated with the proprietary software of their customers, while their Free Software version can be integrated with Free Software only. Finally, other organizations are supported by users that buy Free Software (e.g. Lsongs or PhoneGaim), that can be legally obtained without paying; in this case buying the software is mainly a voluntary way of supporting the developers, or a way to avoiding the hassle of having to obtain the software in a different way which usually involves searching for the software with the use of web search engines, or compiling the software from the source code.

In this paper we aim to analyse Free Software from a different point of view, focusing on *the market and non-market relations inside the community of users and developers of Free Software*.

Some authors, as Raymond (Raymond, 1999), see Free Software mainly from a technical, pragmatic point of view, as a way to obtain better software. Others (Victor, 2003; Moglen, 1999; Benkler, 2002) consider Free Software as the seeds of a different kind of Information Society, that goes beyond the classical model of market economy. We insert our work in this latter group, trying to extend the discussion with our contribution.

The following sections will discuss labour, capital and product and their respective role in the production paradigm of Free Software.

2. Labour and Capital

Pure market values, as money-oriented rewards, are often insufficient to motivate many workers (Herzberg, Mausner, & Snyderman, 1959): once material needs have been met, an increase in the availability of material rewards is no longer sufficient. Instead, fulfilment of higher level needs within the hierarchy of needs (Maslow & Lowry, 1998) is a required to motivate the work force.

This means that esteem and self actualisation needs have to be considered, and that the worker cannot be motivated only by monetary means. The Free Software community is pervaded by what has been defined as *hacker ethics* (Levy, 1984), and this needs to be considered for motivating the developer. It is important to note that in the context of this paper, as in the context of the Free Software community, hacker is neutral term referring to skilled software developers.

The values of passion, freedom, work ethic, money ethic, network ethic, caring and creativity, as described by Himanen (2001), pervade the hacker ethics and the Free Software developers. Freedom is valued as itself, more than any alternatives values, as the hacker ethics *refuses to bow to pure market or convenience*:

“But just because we are competing with proprietary software on issues of technical merit doesn't mean we think people should choose the program for source control based on technical qualities alone. That would mean assigning zero value to freedom itself. If you value freedom, you will resist the temptation to use a program that takes away your freedom, whatever technical advantages it may have” (Biancuzzi, 2004).

Hacker ethics resembles the chieftainship ethics, as described by Malinowsky (1984). The chieftain, as the hacker, is linked to his tribe (his community) by duties and privileges – he can ask for tributes, in terms of work or resources – but his prestige and his ability of claiming work and resources, depend on his contribution to the community. Hackers with a good reputation will be able to involve people in their projects (and in many projects, a huge amount of developers is required), and people will be honoured to be chosen. In exchange, the hackers need to contribute and to demonstrate their commitment to the community. The influence of a hacker that does not contribute to the community will be effectively reduced. This is similar in other communities, as in the scientific community: the scientists with highest status are the ones who have directly and indirectly contributed the most to their fields, not those who possess the most knowledge.

On the other hand, Free Software developers (very often) have commercial interests in software development. This is true for almost all the important Free Software developers, at least at some point of their career. Linus Torvalds, the creator of Linux, has been working at Transmeta (a chip manufacturer) for more than 6 years before moving to the OSDL lab (a non profit organisation). Guido Van Rossum, the author of Python, has been working for several different companies in the past years. Miguel de Icaza, the main developer of Gnome, founded his own consultancy company. At the same time, Free Software developers work inside a community and most of the product of their labour is available to the community. The result is *a dual allegiance of developers,* both to the community and to their companies.

According to Stallman (Laird, n.d.) in the Free Software community there is a moral priority of the community on the business. Nevertheless, many companies (including corporations like IBM or Novell) support the development of Free Software. The interest of corporations is motivated not in the name of ethics, but of market values exclusively, and it could not be differently (Bakan, 2004).

It is clear that the motivations for the support of Free Software are completely different for the labour force and for the capital: non-market values from one side (the hacker ethics), market values from the other. At the present time, each one needs the other and collaboration is the only viable solution to fulfil the self interest of each one: companies can hire developers, and they are free to work in the context of a community that endorses their values.

3. Product

Software and its documentation are distributed according to different types of licensing conditions. The Free Software community itself is using different licenses (the so-called Free Software licenses), according to specific requirements, but they all provide four freedoms (to execute, to study, to redistribute, to improve) to the users, as defined by the Free Software Foundation (Stallman, 2004).

Three main licenses are used in the Free Software community: the GPL (GNU Public License) (Free Software Foundation, 1991), the LGPL (Lesser General Public License) (Free Software Foundation, 1999) and the BSD (Berkeley Software Distribution) license (Open Source Initiative, 2005). The GPL requires that the rights that a user received with a GPL software must be granted by any program derived or linked to it, which means from a practical point of view, that developers including GPL software in their projects must release their work *under the same conditions*. The BSD license allows inclusion of the Free Software in proprietary software. The LGPL is used mainly by libraries (shared components), and allows to use it in any type of software, but requires that any modifications to the software are released under the same conditions.

Free Software licenses do not restrict the user from using Free Software in a non-free operating system (for example users can run Firefox, or OpenOffice.org on a non-free operating system as Microsoft Vista). Nevertheless, Free Software licenses as the GPL or the LGPL can put restrictions on derived works (for example, you cannot alter the Linux kernel and release your changes as proprietary software).

In July 2005, we performed an analysis of the software at SourceForge (sourceforge.net), the widest existing repository of Free Software (including at the time more than 65,000 Free Software projects) to study the diffusion of the different licenses. At that time, we found that nearly 69% of the software included was released under the GPL license, 11% under the LGPL and 7% under the BSD license. A previous analysis by Wheeler (Wheeler, 2005) showed similar results: in 2003, 71% of SourceForge Free Software projects (45,000) were using the GPL, 10% the LGPL and 7% the BSD license. It needs to be noted that the software can be released (and often is) under more than one license and these data refers to software that included the GPL as possible license. Furthermore, in Wheeler's earlier analysis (Wheeler, 2002) of Red Hat Linux 7.1 (Red Hat was and still is the most popular Linux vendor) he found that nearly 50% of its code was released under the GPL only.

This analysis shows how around 70% of the developed Free Software is released under the GPL, which does not allow to integrate the software into proprietary programs, and that an additional 7% can be used in proprietary software but any improvements need to be released as Free Software. The implication is that Free Software and proprietary technology currently cannot be easily mixed. Users can use Free Software and/or proprietary applications, but in the vast majority of cases Free Software applications cannot have proprietary components and vice versa.

The implication is that the Free Software community is creating a niche in which market and non-market relations can develop only between members – companies that do not develop Free Software cannot use Free Software component, and often are not able to market their products to the users of Free Software.

In many cases software developers say that the software is developed "just for fun" (Torvalds & Diamond, 2001). As a consequence, Free Software is characterised by a *precarious usefulness*, as addressed by the GPL itself, in clause 11:

> "there is no warranty for the program, to the extent permitted by applicable law. [...] parties provide the program 'as is' without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose."
>
> (Free Software Foundation, 1991).

Similar clauses are inserted both in the LGPL and in the BSD license.

This strongly supports considering Free Software as permeated with non-marked relations. For this aspect (but not for others, as will be discussed in the next section) a *similitude with the gift* is possible. A gift is given and accepted within a loose evidence of usefulness, and Free Software is distributed "as is" - and may or may not be useful for the user.

Nevertheless, the usefulness of a product is individual, and often it can be maximised, in the users of Free Software, by its freedom.

The usefulness of software, for a user, is strictly linked to the satisfaction of some of the needs of a user. A computer game will be useful if it is providing leisure, and a business application will be useful if it is suitable for the business processes of its user. Free Software is likely to have a very different degree of usefulness for a hacker and for a user that does not know how to use and configure a GNU/Linux system. On the other hand, its precarious usefulness itself opens the way to market relations: companies can provide services, supporting or customising software that by itself might not be suitable to the end user.

4. A different Organization Paradigm

Free software is often considered an element of a gift economy, where goods and services are not traded, but freely given and taken. Gift economies can usually develop in the presence of trust or abundance. When based on trust, individuals share the certainty of reciprocity and will freely give away their goods, or provide service, knowing that they would be able to receive back from the community what needed, at due time. Gift economies based on abundance develop when there is no scarcity of goods and the social status is determined not by what the individuals' controls but by what is given away.

Eric Raymond is one of the supporters of the view of Free Software as a good exchanged using the rules of a gift economy (Raymond, 1999). This perspective is based on the idea that software is a non-scarce good that can be easily shared, because the cost of replication for software tends to zero and thus "the only available measure of competitive success is reputation among one's peers".

However, it can be disputed from a number of different angles that Free Software is not an element of a not gift economy based on trust nor is it based on abundance.

First of all, it is hard to consider Free Software as an element of a gift economy, because a gift requires the property of an inalienable item to be exchanged (Gregory, 1982), while with Free Software no property is exchanged. Proprietary software can be considered as elements of a gift economy, not Free Software.

Moreover, a gift economy is always based on the presumption of reciprocity inside the community, sometimes described as a "delayed market exchange", and there is always a penalty for failing. The Free Software production model is, indeed, based on reciprocity between users and developers, but of a different kind: it is *voluntary*, *delayed* and *tending to immaterial for the developer*.

It is voluntary because it is not obligatory to provide any sort of regard to the author of a Free Software that is used. It is possible and recommended to do so, however it is not mandatory, and even if you disrespect Free Software, you can use it (as long as you respect the license conditions - otherwise you may lose the right to use the software). The example of the SCO case (Shankland, 2003) is meaningful: SCO has been attacking the GPL for several years, as part of their controversy against Linux (Galli 2003) but nevertheless this does not imply that they cannot use GPL software (they are still using and distributing GPL software in their products).

The reciprocity is delayed, because the regard is not usually given for the access to the software, but after the use of the software itself, if the users appreciate it. The developer of software may not get any form of immediate regard for producing Free Software. It may happen, in some cases, when Free Software is produced within the horizon of a business project; for example Free Software may be commissioned by a customer, or may be developed as part of the commitment of an organisation to a Free Software project, or may be due for realising a service that is to generate revenues. In other situations, the regard will be delayed in time, if and when the use the software will grow. To point out the difference, the regard for the production of proprietary software is generally monetary and strictly linked to the access to the software itself. While software companies may publish demo versions or development versions of software, for the full, working software a fee is required in most cases. On the other hand, while in a gift economy the regard is linear, in the Free Software model the regard is exponential, thanks to the free circulation of the software.

Moreover, the reciprocity is tending to immaterial, because once a user acquires a copy of a Free Software, it can be given to any number of other users, and its price quickly tends towards zero. In a market economy, the cost of a product is usually decomposed as the cost of the product itself and the cost of transfer. Buying in a shop a t-shirt has a cost of transfer, that is the cost of shipping the t-shirt from its manufacturing location to the shop, and the cost of manufacturing. In a gift economy, a product has a value (based on cost of production and cost of transfer), but it is given for free, on the basis that the gift will be reciprocated. In the case of Free Software, any user that acquires (for a price or for free) a copy of the software can redistribute it, for a price or for free. This implies that in most cases the value will quickly tend towards zero, and that a immaterial regard may be the only regard that the developer is receiving from most users.

When we receive something with a non-market transaction, we do not pay not the product nor the transfer in exchange for the good. This is the case of Free Software, but as we have seen we are facing non-market relations that do not appear in the context of a gift economy.

By contrast with the non-market relations that happen in a gift economy, *we can define the Free Software community as a socioeconomic system in which the access to goods do not require an agreement upon a quid pro quo, reciprocation or regard, but obedience to a defined set of rules which define the possible use of the good.*

We can as well foresee how production numbers that tends towards to infinite and a common access to non scarce products that can be easily shared would overcome the dilemma posed by the capitalist model of production on how to distribute a scarce production. Thus, the Free Software model implies a different approach to the scarcity of resources and to the diffusion of innovation.

We have already seen how companies have to accept the hacker ethics to be part of the Free Software community, not very different from Venetian merchants accepted in the Feudal economy. Free Software is not a collateral experiment, or a small community, and if we accept that infrastructure is depending from the production structure, we may foresee a change in the organisational structures that are involved in the development of software, and we may have the seeds for different production models for the Information Society.

5. References

Bakan, J. (2004). *The corporation: The Pathological Pursuit of Profit and Power*. London: Constable & Robinson Ltd.

Benkler, Y. (2002). *Coase's Penguin, or Linux and the Nature of the Firm*. Retrieved September 1, 2005, from ttp://www.yale.edu/yalelj/112/BenklerWEB.pdf

Biancuzzi, F. 2004. *Freedom, Innovation, and Convenience: The RMS Interview.* Retrieved September 1, 2005, from http://www.linuxdevcenter.com/pub/a/linux/2004/12/22/rms_interview.html

Bollinger, T. (2003). *Use of Free and Open-Source Software (FOSS) in the U.S.* Retrieved September 1, 2005, from www.egovos.org/rawmedia_repository/588347ad_c97c_48b9_a63d_821cb0e8422d?/document.pdf

Bonaccorsi, A., & Rossi, C. (2003). Why Open Source Software can succeed. In *Research Policy*, *32*, 1243-1258.

FLOSS Project (2002). *Free/Libre and Open Source Software: Survey and Study*. Retrieved September 1, 2005, from http://flossproject.org/report/

Free Software Foundation (1999). *GNU Lesser General Public License*. Retrieved 1 September, 2005, from http://www.gnu.org/licenses/gpl.html

Free Software Foundation (1991). *GNU General Public License*. Retrieved September 1, 2005 from http://www.gnu.org/licenses/gpl.html

Galli, P. (2003). *SCO Group Launches Broadside Against GPL*. Retrieved December 28, 2007, from http://www.eweek.com/article2/0,1895,1404984,00.asp

Gregory, C. 1982. *Gifts and Commodities*. London: Academic Press.

Haruvy, E., Prasad, A., & Sethi, S.P. (2003). Harvesting altruism in Open Source Software development. In *Journal of Optimising Theory and Applications*, *118*(2), 381-416.

Hertel, G., Niedner, S., & Herrmann, S. (2003). Motivation of software developers in Open Source projects: An Internet-based survey of contributors to the Linux kernel. In *Research Policy*, *32*, 1159-1177.

Herzberg, F., Mausner, B., & Snyderman, B. B. (1959). *The motivation to work*. London: J.Wiley.

Himanen, P. (2001). *The Hacker Ethic and the Spirit of the Information*. London: Random House, Incorporated.

Laird, C. (n.d.). *How free is open? An interview with Richard M. Stallman*. Retrieved September 1, 2005, from http://www.developer.com/open/article.php/603961

Lapavitsas, C. (2004). Commodities and gifts: Why commodities represent more than market relations. In *Science & Society*, *68*(1), 33-56.

Lakhani, K., & Wolf, R. (2005). *Why hackers do what they do: Understanding motivation and effort in Free/Open Source Software Projects*. Retrieved September 1, 2005, from http://ssrn.com/abstract=443040

Lerner, J., & Tirole, J. (2001). The Open Source Movement: Key research questions. In *European Economic Review*, *45*, 819-826..

Lerner, J., & Tirole, J. (2002). Some simple economics of Open Source. In *The Journal of Industrial Economics*, *50*(2), 197-234.

Levy, S. (1984). *Hackers: Heroes of the Computer Revolution*. USA: Bantam books.

Malinowski, B. (1984). *Argonauts of the Western Pacific*. Illinois, USA: Waveland Press.

Maslow, A., & Lowry, R. (1998). *Toward a Psychology of Being*. New York: Wiley & Sons.

MIT Open Source Group (2002). *Why Open Source?* Retrieved September 1, 2005, from http://opensource.mit.edu/what_is_os.html

Moglen, E. (1999). *Anarchism triumphant: Free software and the death of copyright*. Retrieved September 1, 2005, from http://firstmonday.org/issues/issue4_8/moglen/index.html

Open Source Initiative (2005). *The BSD License*. Retrieved 1 September, 2005, from http://www.opensource.org/licenses/bsd-license.php

Perens, B. (1999). The Open Source Definition. In C. Di Bona, S. Ockman, & M. Stone (Eds.), *Open Sources: Voices from the Open Source Revolution*, (pp. 171-189). O'Reilly Media.

Raymond, E. S. (1999). *Homesteading the Noosphere*. Retrieved September 1, 2005, from http://www.firstmonday.org/issues/issue3_10/raymond/

Sahlins, M. (1972). *Stone age economics*. Chicago : Aldine-Atherton.

Shankland, S. (2003) . *SCO attacks open-source foundation*. Retrieved September 1, 2005, from http://news.com.com/SCO+attacks+open-source+foundation/2100-7344_3-5098610.html

Stallman, R. (2002). Copyleft: Pragmatic Idealism. In J. Guy (Ed.), *Free Software, Free Society: Selected Essays of Richard M. Stallman* (pp. 91-95). Boston, MA: Free Software Foundation.

Stallman, R. (1988). *The GNU Project.* Retrieved on December 28, 2007 from http://www.gnu.org/gnu/thegnuproject.html

Stallman, R. (2004). *The Free Software Definition*. Retrieved September 1, 2005, from http://www.fsf.org/philosophy/free-sw.html

Torvalds, L., & Diamond, D. (2001). *Just For Fun: The Story of an Accidental Revolutio*. USA: Texere Publishing.

Victor, R. (2003). *Free Software and Market Relations*. Retrieved September 1, 2005, from http://www.oekonux.org/texts/marketrelations.html

Werbach, J. L., & Dreben, R. N. (2003). The Accidental Licensor: Advanced Issues in Software Licensing. In *ACCA Docket*, *21*(2), 54-71.

Wheeler, D. A. (2002). *More Than a Gigabuck: Estimating GNU/Linux's Size*. Retrieved September 1, 2005, from http://www.dwheeler.com/sloc/redhat71-v1/redhat71sloc.html

Wheeler, D. A. (2005). *Make Your Open Source Software GPL-Compatible. Or Else*. Retrieved September 1, 2005, from http://www.dwheeler.com/essays/gpl-compatible.html