Ubiquitous Computing and Pervasive Adaptation of Social Norms in Workplace Design

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Abstract. The design of workplaces, namely the physical arrangement of people and machines, has an active influence on work-related issues, such as productivity and efficiency.

However, even an ideal physical arrangement of machines is subject to the social and emotional intelligence of the people. It is possible to formalise the former using rules of social order, and to capture the latter using the ideas from Affective Computing.

Our intention, then, is to demonstrate that by integrating affective states and participatory/pervasive adaptation of social norms in workplace design, the quality of experience in a working environment can be improved.

1 INTRODUCTION

The design of workplaces, namely the physical arrangement of people and machines, has an active influence on work-related issues, such as productivity and efficiency. This arrangement can be an inhibitor or a facilitator to more social interactions [19]. It is a goal of today's organisations to find ways to effectively use office work environments as means to improve worker performance. Moreover, group performance has become a main question for businesses that rely on collaborative work to achieve the organisational goals [6, 14]. Thus, it is essential that office environments are designed with the purpose of providing dynamic, user-friendly space [22].

It has been argued that social and emotional intelligence are the parts of human intelligence that most influence aspects of success in life, especially in social interactions, learning, and adapting to what is important [20]. Emotions play a critical role in cognitive processes in humans, such as focus and attention [10], organisation of memory and perception [3], motivation and performance [7], planning [17], learning [11], goals generation, evaluation and decision-making [9], and communication [2, 12]. Therefore to study an office environment we should leverage the emotions of each of the individuals that are part of the workplace with technology, to improve the interaction.

Besides the psychological and neurological documentation suggesting the influence of emotions in human interactions, there is evidence to justify that more specifically, emotions influence human interaction with computers. It has been shown that providing positive affective interventions to people who are having difficulties solving a problem with a computer, increases their performance [21]. This conclusion was gathered in an experiment that studied the psycho-physiological effects of positive and negative affective interventions in human-computer interactions. Subjects were exposed to pre-programmed mouse delays, while trying to solve an interactive puzzle. After that, positive or negative interventions were provided via a speech synthesiser and the subjects' responses were recorded and analysed. Another experiment was conducted by Kapoor et al. with the aim of assessing user frustration. A set of children were asked to solve a computer version of the Towers of Hanoi puzzle. The subjects' non-verbal multimodal data was analysed, with the objective of trying to predict when the children were feeling frustrated [16]. Branco et al. observed the spontaneous facial expressions subjects portray while trying to format a document in Microsoft Word, with the objective of identifying adverse event occurrences in the user interface [4]. It has also been proven that while working with computers, people display emotions that are caused by the interaction with the computer. [26]. To assess this, an experiment where some people were continuously recorded while working in their every tasks with the computer, was conducted. Sequences where people were showing emotions that were caused by the interaction with the computer were extracted. Some of these video sequences were presented to 75 people on an online questionnaire, who clearly agreed in the labelling of affective states such as frustration, fatigue and concentration.

In any experimental study it is necessary to consider cultural variations. Cultural personal characteristics influence the way people interact and view each other [5]. For instance, certain behaviours can be seen as natural in a culture and as offensive in another. Also, people from different cultural backgrounds display emotions in different ways. Cultural differences have always influenced the way users interact with computers [23]. Even though cultural issues should not be ignored, "there seems to be a gap between notions of technology and culture, and a lack of appropriate and valid approaches to their synchronisation [27]". A reason for this lack of synchronisation can be explained by the conclusions Kamppuri et al. [15] gathered after examining literature from the main HCI-related journals and conference proceedings published from 1990 to 2005. They concluded that from the 3286 published papers only 28 referred cultural issues in HCI, which represents about 0.85% of all the publications. There are still only a few studies of the ways cultural diversity may influence the users' interaction with computers, so it "has become a new challenge for HCI [15]".

2 RESEARCH QUESTIONS

Ubiquitous Computing (ubicomp) aims at creating digital environments that are sensitive to human needs, and adapt and respond accordingly [25]. In these environments, pervasive applications become ideally invisible, which is made possible by their degree of integration and need for minimal human input. For all this to be achievable, systems and devices that are part of the digital environment need to be context-aware and use this context-awareness smartly. Ubicomp

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requires systems and devices that perceive context in an accurate way, followed by intelligent control or action between machines and humans [25].

We believe group interactions in workplaces could be improved by using ubicomp techniques to detect affective states, followed by a participatory definition and pervasive adaptation of social norms.

We intend to study how social norms in workplaces can be created and adapted taking into account the emotional states of each person that is part of that workplace. After that we want to study in what way all elements of the workplace comply with the created social norms - whether or not there are elements that break the norms, the motivations for breaking the norms and procedures to rehabilitate trust. We also want to know in what way cultural factors affect the behaviour and display of emotions in the workplace.

The first step of the study is to analyse the workplace as a whole and also each of its human elements individually. Visual cues are expected to provide valuable information about the way people react to situations that might be distracting, break concentration, or in any case upset the work stream. Therefore video cameras and web-cameras should be placed around the workplace so that both the interaction between people and each person's reactions are filmed.

The web-cameras should be used to individually record each person, storing personal reactions and displays of emotions that happen when any of the previously referred situations happens. Since cultural differences influence the way people from distinct cultural backgrounds behave, the web-cameras might not be sufficient to provide full information about emotions being felt at a certain moment. Therefore, as an additional experiment we might use brain sensors to analyse different cultural behaviours and displays of emotions.

The video cameras should be strategically placed in the workplace so they capture the interactions and general actions that might be the cause of some group reaction.

We only need to keep the recordings of the minutes immediately before, during and after the moment when some situation affects several elements of the workplace. For those moments the recordings need to be synchronised so they can be analysed as a global event where all reactions and displays of emotions might have been caused by the same situation.

Evidence from several areas of research, such as, for instance, medical studies and social support groups, suggest that people reveal more socially undesirable information about themselves in Computer Mediated Communications (CMC) than when compared to the equivalent face-to-face interaction [13]. It is therefore expected that when people break the social norms of the workplace, their colleagues won't confront them. If this situation persists it might lead to a bad work environment, since it represents a break in the general trust that everyone will follow the norms. By not confronting the breaker of the norms, who might not even be aware s/he has broken them, the remaining elements of the workplace don't give her/him a chance to apologise and/or explain her/himself. And as Vasalou et al. argue, when an offender has the opportunity to repair the action (in this case, whatever broke a social norm), the victim's trust can be restored [29].

Since we want to understand the whole social norms' interaction process, i.e. the way people comply with the norms and how they react when something breaks them, it is important that people express their opinions freely without the social barriers a confrontational situation might impose. So, to help achieve real results, some mechanisms to facilitate the resolution of these conflicts will be developed, in a CMC way.

Some initial formulation of research questions has been made. Though there are already some tentative answers to some of the questions, only the research conducted throughout this study will provide full understanding of the problem.

2.1 What data will be used?

To define the social norms we will need input from everyone that is part of the workplace. This input is composed of descriptions and requests from people, and also of conclusions gathered from observations of people's behaviours. The latter is perhaps the most important input. Often people don't know what they need, especially when it comes to future interactions, which they're not used to dealing with [18]. As stated before, this observation will be made indirectly, by placing video cameras and web-cameras in the workplace, and eventually by measuring additional inputs, such as brain signals, for instance.

2.2 What are the characteristics of the system to be created?

The system to be created is one that provides a computer-mediated interaction between everyone in the workplace, especially between people that are affected by someone else's behaviour (the victims), and the person or persons that behave in a way that upsets other elements of the workplace (the offenders).

The set of social norms will be mapped in the system through a policy-based language. The system will also comprehend decision-making tools, which control all feedback provided, such as, for instance, emails warning the offender of his/her inadequate behaviour. These decision-making tools will receive as inputs the social norms policies and historical data about previous offences and everyone's reactions to those offences. Inputs from brain sensors will eventually be added at a later stage. The brain sensors should provide real-time information about affective states and facial expressions of each person of the workplace.

The envisioned system needs to provide a solution for victims who are too introvert to let the offenders know they're upsetting them, to indirectly do so. This interaction might be anonymous so that people who might feel inhibited by direct confrontations, do not feel constrained in signaling offences.

All violations of norms will be reported by individuals, usually by the elements of the workplace. In order to have have an automatic detection of these offences, there would have to be automatic video analyses, which are not part of the scope of this study.

The system should also collect and relate data, such as:

- Who are the offenders (who has ever broken a social norm),
- How often each offender breaks the social norms,
- How many of the victims signal each of the offences (the breaking of the norms),
- How the offenders react to negative feedback from the system (whether or not they try to change their behaviour, whether or not they provide an explanation for it, ...),
- How the victims react to the redeeming behaviour from the offender.

Additionally, the system should keep every element of the workplace informed about the social norms and their personal level of compliance with them. For instance, an element that has never broken the social norms has a higher level of compliance than someone who has been an offender before.

Given the system's automated reasoning and decision-making on what is signalled as a violation of the norms, classification errors might occur occasionally. Since the offences are always flagged by the human elements of the workplace, and the system then decides whether or not to signal flagged events as violations, if classification errors happen, they are expected to happen because the system was too conservative in considering something as an offence, rather than classifying an innocuous action as a violation.

2.3 What techniques will be used?

The techniques to be used comprehend, among others:

- Analyses of inputs from the web-cameras and video cameras placed around the workplace.
- Interviews with workplace elements.
- Analyses of data generated by the usage of the system.

2.4 What interfaces will be created?

The full set of interfaces to be created in the system will be defined in a later stage of this study, as some of the interfaces will be a reflection of the needs of the workplace.

The system will be installed in each computer of the workplace, so everyone has access to the same tools and information. There is information about the social norms and the self- and other people's behaviour towards them.

This information might be presented in a map of the workplace. Here each of its human elements might be represented by an avatar that is colour-coded, according to the person's level of compliance with the social norms. This colour codification is based on the reasoning made by the system about each element's compliance with the norms and should vary throughout time.

When someone breaks the norms, every element of the workplace that feels upset by that behaviour can (and should) click on the offenders' avatars and send feedback about their behaviour. This feedback should also indicate what kind of action caused the person to feel upset, either the breaking of an established social norm, or a different action that is not (yet) contemplated by the norms. Also, the offenders should know how many people are disturbed by their behaviours and exactly what action caused the disturbance.

An offender can redeem her/himself by sending feedback to the people who complained, explaining why s/he broke the social norms. After this interaction the victim(s) should decide whether or not to change the rating they initially gave to the offender.

2.5 How will the social norms be expressed and adapted?

The social norms will be expressed in the system through a policy-based language, probably ALP [1]. Policies are used to dynamically control the behaviour of system components without the need to change the code. They provide the flexibility of implementing variations in the system that reflect externally imposed constraints or environmental conditions [28].

The social norms will be initially defined after observation of the work group and the individuals, and by interviewing everyone who is part of the workplace. At least the majority of the workplace elements have to agree on a rule for it to be established as a social norm for that workplace.

The policies will then be set to define the rules of behaviour in the workplace. They will be one of the inputs for the system's decision making module.

After the system is implemented, the data collected from all the interactions will be periodically analysed. This new information might point towards the need to create new social norms, based on indications from victims of behaviours considered to be disturbing to the workplace harmony. Once again, whenever a new social norm or a change in an already existing social norm is proposed, there has to be a high level of agreement between the elements of the workplace, for it to be implemented.

2.6 How are emotions going to be related and mapped with the social norms?

Although there are various descriptions for affect, we are going to use the one proposed by Russell [24], as it is simple and capable of capturing a wide range of emotions and shades of emotions [8]. Russell defines a multidimensional emotional space where a horizontal and a vertical axis define positive and negative values of valence and arousal, respectively. Each emotion or affective state falls within one of the quadrants defined by these two axes.

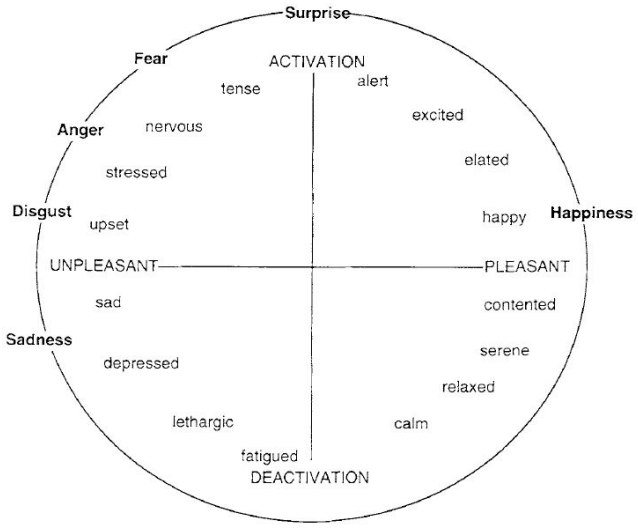

Figure 1. Russell's circumplex model of affect

The four distinct quadrants represent combinations of activation/deactivation and positive/negative affective states. Valence ranges from unpleasant to pleasant affective states. Arousal defines a level of emotional activation that ranges from low (i.e. fatigue) to high (i.e. alertness).

As we want to analyse what happens when some event upsets the regular work pace, the most relevant quadrant is the upper left one, as it represents unpleasant and active emotions. Hence, the main attention in the analysis of individual emotions should be given to cases where people are feeling upset, frustrated, distracted and annoyed, amongst others, when these affective states are caused by the actions of someone else in the workplace. If certain actions cause some kind of emotional reactions (with special focus on the ones from the up/left quadrant) in a continuous way, those actions might be proposed as a "what not to do" in the workplace, and originate new social norms.

2.7 How is the system going to be evaluated?

The overall objective of the system is to facilitate communication, so that group interaction in the workplace is improved. The evaluation of the system has to be done in two ways: assessing in which manner the group interaction is affected by the system; and evaluating the system's performance.

Immediate indicators to assess in what way the workplace environment has been improved, are the amount of offences reported in the system and the individual ranking of each element of the workplace. For the system to be successful these rankings should be improved and the total number of reports should decrease. Interviewing the workplace elements should also provide information about the way the workplace environment has changed by the introduction of the system.

When it comes to the system's performance, there should be additional filming that captures people's reactions to triggered breaking of the norms. These reactions should then be compared to the system's assumptions for those same situations, in establishing which of those actions were breaking the norms, and the consequent provided feedback.

3 CONCLUSIONS

One of the goals of today's organisations is to find ways of effectively using office work environments as a means to improve worker performance [19]. We believe one way of doing so is by improving the quality of experience in a working environment, by integrating affective states and participatory/pervasive adaptation of social norms in the workplace design.

We will start this study by analysing the workplace structure both collectively and individually. For this purpose, video cameras and web cameras will be placed in the workplace to be studied. The video cameras will capture global actions in the workplace, including the actions that might upset the work pace. The web cameras are expected to show individual displays of emotions by each of the human elements of the workplace, and will, therefore, be placed in front of each of those elements. With the outputs of these recordings and information gathered in interviews with the people of the wokplace, social norms will be defined.

There is evidence that suggests people reveal more socially undesirable information about themselves in CMC than when compared to equivalend face-to-face interaction [13]. We propose to build a system that will include the previously defined social norms, expressed by a policy language. This system will work as a mediator between the people in the workplace, and will help them to provide feedback about their satisfaction with the workplace environment. This feedback includes especially the cases where people feel harmed by the breaking of the norms by another element of the workplace. It has been shown that often when an offender has the opportunity to apologise and repair the damage s/he has caused, the victim's trust can be restored [29]. Hence it is another objective of the system to serve as a means of enabling trust recovery actions.

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